

This electronic thesis or dissertation has been downloaded from the King's Research Portal at <https://kclpure.kcl.ac.uk/portal/>



Anhedonia in Schizophrenia: The Roles of Anticipatory and Consummatory Pleasure

Edwards, Clementine Jane

Awarding institution:
King's College London

The copyright of this thesis rests with the author and no quotation from it or information derived from it may be published without proper acknowledgement.

END USER LICENCE AGREEMENT



Unless another licence is stated on the immediately following page this work is licensed

under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International

licence. <https://creativecommons.org/licenses/by-nc-nd/4.0/>

You are free to copy, distribute and transmit the work

Under the following conditions:

- Attribution: You must attribute the work in the manner specified by the author (but not in any way that suggests that they endorse you or your use of the work).
- Non Commercial: You may not use this work for commercial purposes.
- No Derivative Works - You may not alter, transform, or build upon this work.

Any of these conditions can be waived if you receive permission from the author. Your fair dealings and other rights are in no way affected by the above.

Take down policy

If you believe that this document breaches copyright please contact librarypure@kcl.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.

Anhedonia in Schizophrenia: The Roles of Anticipatory and Consummatory Pleasure

Clementine J. Edwards

Institute of Psychiatry, Psychology &
Neuroscience

This thesis is submitted to King's College London for the degree of
Doctor of Philosophy

2015

Abstract

The negative symptoms of schizophrenia, particularly anhedonia and amotivation, are associated with poor functioning and contribute to the chronicity of the illness. There are currently very few targeted interventions available for these difficulties. The Temporal Experience of Pleasure model suggests that there is a specific deficit in anticipatory pleasure in people with schizophrenia. However, studies in this field have produced conflicting results.

The studies conducted had three broad aims. The first was to assess self-reported pleasure and its association with symptoms and mood. The second was to develop an experimental task that measured, for the first time, both anticipatory and consummatory pleasure using the same stimuli. This allowed a direct test of the hypothesis that there is a specific anticipatory pleasure deficit in people with schizophrenia. The final aim was to examine whether reduced anticipatory pleasure contributes to lower activity levels in everyday life.

The results demonstrated that people with schizophrenia had comparable levels of anticipatory and consummatory pleasure to controls but a larger discrepancy between these ratings. Furthermore, anticipatory pleasure and expectation drive activity levels in the everyday life of control participants but these links were not present in people with schizophrenia. Positive affect was found to influence anticipatory pleasure across all three methodologies.

These findings suggest that people with schizophrenia have difficulty translating anticipation into goal-directed activities. Positive mood may be an important contributor to anticipatory pleasure. The link between anticipation and activity may be an important therapeutic target for improvement in both negative symptoms and functional outcomes.

Table of Contents

Chapter 1: Introduction	19
1.1 Schizophrenia	19
1.1.1 Factors Influencing Functional Outcomes in People with Schizophrenia	21
1.2 Negative Symptoms	22
1.3 Measurement of Negative Symptoms	26
1.3.1 The Need for Reliable Measures.....	26
1.3.2 Aetiology of Negative Symptoms	27
1.3.3 Are Negative Symptoms Related to Depression?	27
1.3.4 Current Measures of Negative Symptoms	28
1.3.2 Distinctions Within Negative Symptoms	30
1.3.3 The Use of Experimental Paradigms in the Assessment of Pleasure	34
1.3.4 The Experience Sampling Approach	35
1.3.5 Summary of the Current Measures of Negative Symptoms	38
1.4 Models of Anhedonia and Amotivation	39
1.4.1 Temporal Experience of Pleasure Model: Anticipatory Deficit Hypothesis	40
1.4.2 Affective Forecasting Literature	43
1.4.3 Three-Component Model of Anhedonia in Schizophrenia (G. P. Strauss & Gold, 2012).....	45
Chapter 2: Empirical Support for Therapeutic Targets proposed by the Temporal Experience of Pleasure Model in Schizophrenia: A Systematic Review	48
2.1 Introduction.....	48
2.2 Method.....	49
2.2.1 Study eligibility	50
2.2.2 Search Criteria	50

2.3 Results	51
2.3.1 Measures of Anhedonia	53
2.3.2 Consummatory Pleasure	54
2.3.3 Memory	55
2.3.4 Executive Functions and Representation Activation/Maintenance.....	59
2.3.5 Anticipatory Pleasure	67
2.3.6 Approach Motivation/Behaviour.....	70
2.4 Discussion.....	73
2.4.1 Potential Therapeutic Targets	73
2.4.2 Evaluation of the Systematic Review	74
2.5 Limitations of Current Evidence Base and Future Directions	74
2.6 Thesis Rationale	76
2.7 Research Questions.....	79
Chapter 3: Methodology.....	82
3.1 The Components of Pleasure (COP) Task.....	83
3.1.1 Task Rationale.....	83
3.1.2 Computer Task Procedure	87
3.1.3 COP Task Pilot Study.....	90
3.2 Experience Sampling	96
3.2.1 Rationale.....	96
3.2.2 ESM Questionnaire Development	97
3.2.3 Devices.....	102
3.2.4 Experience Sampling Methodology Protocol	102
3.2.4.1 Phase 1 Briefing Session	103
3.2.4.2 Phase 2 Experience Sampling Study	103
3.2.4.3 Phase 3 Debriefing Session.....	103

3.2.5 Experience Sampling Pilot Study	104
3.2.6 Service User Consultation.....	107
3.3 Ethical Considerations	107
3.3.1 Consent	107
3.3.2 Confidentiality	108
3.3.3 Burden	108
3.4 Total Sample.....	109
3.4.1 Schizophrenia (SZ) Group	109
3.4.2 Control Group	109
3.4.3 Recruitment Procedure	110
3.5 Power Calculations	111
3.5.1 Chapter 5: Reliability and Validity of the COP Task.....	111
3.5.2 Chapters 4 and 6: Experimental and Self-Report Assessments of Anticipatory and Consummatory Pleasure	112
3.5.3 Chapter 8: Experience Sampling.....	112
3.5.4 Chapters 4, 5, 6, 7 and 9: Correlational Analyses	112
3.6 Measures	113
3.6.1 Scales for Clinical Attributes and Functioning Only Assessed in the Clinical Group:	113
3.6.2 Anhedonia Scale for Use in Both the Control and Clinical Populations:	115
3.6.3 Questionnaires Measuring Potential Moderating Factors:.....	116
3.6.4 Acceptability of the Experience Sampling Study in Both Groups:.....	117
3.6.5 Clinical Screening of Control Participants: Mini International Neuropsychiatric Interview (Sheehan et al., 1998)	117
3.7 Study Procedure	118
3.8 Analysis.....	120

3.8.1 Data Quality	120
3.8.2 Descriptive Statistics	120
3.8.3 Chapter 4: Relationships between TEPS Subscales, Mood and Negative Symptoms	121
3.8.4 Chapter 5: Reliability and Validity of Computer Task.....	121
3.8.5 Chapter 6: Anticipatory and Consummatory Pleasure in an Experimental Context: The COP Task	121
3.8.6 Chapter 7: Experience Sampling Acceptability and Internal Validity	122
3.8.7 Chapter 8: Anticipatory and Consummatory Pleasure in Everyday Life: Experience Sampling Study: Multi-Level Modelling.....	123
3.8.8 Chapter 9: Combined TEPS, Experience Sampling Study and COP Task Analysis .	125
Chapter 4: The Temporal Experience of Pleasure Scale: Self-Reported Anticipatory and Consummatory Pleasure in the Wider Context of Mood, Symptoms and Functioning	126
4.1 Introduction.....	126
4.1.1 Relationship between TEPS Subscales and Mood	126
4.1.2 Relationship between TEPS Subscales and Medication	127
4.1.3 Relationship between TEPS Subscales and Symptom Levels	127
4.1.4 Relationship between TEPS Subscales and Functioning	129
4.1.5 Mood and Medication as Potential Moderators	129
4.1.6 Aims and Hypotheses	130
4.2 Method.....	130
4.2.1 Sample	130
4.2.2 Measures	130
4.2.3 Procedure	131
4.2.4 Analyses	131
4.3 Results	132
4.3.1 Between-Group Differences in the TEPS Subscales	133

4.3.2 Associations between TEPS Subscales and “State” Positive and Negative Affect (PANAS).....	133
4.3.3 Are the TEPS Subscales Associated with Negative Symptom Measures?.....	134
4.3.4 Are the TEPS Subscales Associated with Functioning?	135
4.4 Discussion	135
4.4.1 Future Utility of the TEPS	136
Chapter 5: Reliability and Validity of the Components of Pleasure Task.....	138
5.1 Introduction.....	138
5.2 Methodology.....	140
5.2.1 Sample	140
5.2.2 Measures	140
5.2.3 COP Task	140
5.2.4 Procedure	141
5.2.5 Analyses	141
5.3 Results	142
5.3.1 Data Quality.....	144
5.3.2 Response Times and Learning Characteristics	144
5.3.3 Reliability	145
5.3.4 Convergent Validity	146
5.4 Discussion.....	147
Chapter 6: The COP Task: The Discrepancy between Anticipatory and Consummatory Pleasure in Individuals with Schizophrenia and a Control Group.....	149
6.1 Introduction.....	149
6.2 Method.....	152
6.2.1 Sample	152
6.2.2 Measures	152

6.2.3 Procedure	152
6.2.4 COP Task	152
6.2.5 Analyses	154
6.3 Results	155
6.3.1 Assessment of Potential Moderators: Mood and Medication	155
6.3.2 Are Pleasure Deficits Related to Negative Symptom and Functioning Scores?	156
6.3.3 Consummatory and Anticipatory Ratings.....	157
6.3.4 Anticipatory - Consummatory Discrepancy Scores	158
6.4 Discussion	160
6.4.1 Implications & Future Directions.....	162
Chapter 7: Validity and Acceptability of Experience Sampling Methodology in a Community Sample with Schizophrenia and a Control Group	164
7.1 Introduction.....	164
7.2 Method.....	166
7.2.1 Sample	166
7.2.2 Experience Sampling Protocol	167
7.2.3 Measures	167
7.2.4 Analyses	168
7.3 Results	170
7.3.1 Adherence.....	171
7.3.2 Fatigue Effects	171
7.3.3 Potential Moderators of Adherence: Symptoms, Medication and Employment.	173
7.3.4 Acceptability and External Validity Questionnaire Ratings	174
7.4 Discussion	174
7.4.1 Adherence and Moderators of Completion Rates	174
7.4.2 Acceptability and Disruption	175

Chapter 8: An Experience Sampling Study of Pleasure, Motivation and Activity in Everyday Life	177
8.1 Introduction.....	177
8.2 Method.....	181
8.2.1 Sample	181
8.2.2 Measures	181
8.2.3 Procedure	182
8.2.4 Analyses	182
8.3 Results	184
8.3.1 Demographics	185
8.3.2 Everyday Life Activity Levels	185
8.3.3 Mood, Pleasure, Expectation and Motivation Between-Groups Analyses	185
8.3.4 Is there an Association between Current Context (Mood and Enjoyment) and Anticipatory Pleasure and Expectation?	191
8.3.5 Variability of Anticipatory Pleasure, Consummatory Pleasure and Expectation over Time	192
8.3.6 Which Anticipatory Constructs Predict Activities Occurring?	193
8.3.7 Social Findings	195
8.3.8 Social Activity.....	195
8.3.9 Between-Group Differences in Social Pleasure and Preferences	196
8.3.10 Association between Current Context (Mood and Pleasure) and Social Anticipatory Pleasure	197
8.3.11 What Predicts Future Social Activity?	198
8.3.12 Are Consummatory Pleasure, Anticipatory Pleasure, Motivation or Expectation Associated with Experiential Negative Symptoms?	198
8.4 Discussion	200
8.4.1 Are There Between-Group Differences in the Constructs from the TEP Model?	200

8.4.2 Associations with Current Context	200
8.4.3 Predictors of Activity	202
8.4.4 Disparity in the Social-Specific Findings	202
8.4.5 Are Anticipatory, not Consummatory, Constructs from the TEP Model Associated with Experiential Negative Symptoms?.....	203
8.4.6 Summary.....	204
Chapter 9: To What Extent do the Three Methodologies Assess the Same Constructs? ..	205
9.1 Introduction.....	205
9.2 Method.....	207
9.2.1 Sample	207
9.2.2 Measures	207
9.2.3 Analyses.....	208
9.3 Results	208
9.3.1 To What Extent are Anticipatory and Consummatory TEPS Subscales and ESM Anticipatory and Consummatory Ratings Measuring the Same Constructs?	209
9.3.2 To What Extent are Non-Social Anticipatory and Consummatory COP Task Ratings and ESM Non-Social Ratings Measuring the Same Constructs?	210
9.3.3 To What Extent do the <i>Social</i> Anticipatory and Consummatory COP Task Ratings Measure the Same Constructs as the Social ESM Ratings?.....	212
9.4 Discussion.....	214
9.4.1 TEPS and ESM Ratings of Anticipatory and Consummatory Pleasure.....	215
9.4.2 COP Task and ESM Ratings of Anticipatory and Consummatory Pleasure	215
9.4.4 Summary.....	217
Chapter 10: Discussion.....	218
10.1 Overall Aims	218
10.2 Summary of the Systematic Review and Rationale	218
10.3 Summary of Findings.....	219

10.3.1 Temporal Experience of Pleasure Scale	219
10.3.2 COP Task	220
10.3.3 Experience Sampling Study	221
10.3 Interpretation of the Findings	224
10.3.1 Temporal Experience of Pleasure Model (Kring & Caponigro, 2010)	224
10.3.2 Why do People with Schizophrenia have Difficulty Linking Anticipation and Activity?	227
10.4 Limitations	231
10.5 Future Directions for Research	233
10.5.1 Current Utility and Further Development of the COP Task.....	233
10.5.2 Executive Function and Working Memory Deficits	233
10.5.3 Further Development of the Experience Sampling Protocol	234
10.6 Clinical Implications.....	235
10.6.1 Therapeutic Targets.....	235
10.6.2 Clinical Approaches	236
10.7 In Conclusion	241
References	242
Appendices	264
Appendix 1: PRISMA criteria completed for the systematic review (Chapter 2).....	264
Appendix 2: Full Table of Studies Included in Systematic Review and Categorisation by TEP Model Construct.....	268
Appendix 3: Image Ratings Questionnaire for COP Task Pilot Study	291
Appendix 4: Verbal Instructions for COP Task	292
Appendix 5: COP Task Neutral Images	294
Appendix 6: COP Task Social Images	295
Appendix 7: COP Task Physical Images	296

Appendix 8: Screenshot of COP Task Consummatory Rating	297
Appendix 9: Screenshots of COP Task Anticipatory Phase Ratings.....	298
Appendix 10: Learning Aid given to Participants during the Learning Phase of the COP Task	299
Appendix 11: Normality Analyses for Chapter 9: Q-Q Plots	300
Appendix 12: Screenshots of ESM Questionnaire Items	304

Table of Figures

Figure 1: The Temporal Experience of Pleasure model. Triangles represent pleasure-related processes, circles represent long-term and working memory components and squares represent motivation and activity components	40
Figure 2: The three-component model: beliefs, mood and pleasure components (G. P. Strauss & Gold, 2012)	46
Figure 3: Section of the adapted TEP model proposing the stages between anticipation and activity.....	47
Figure 4: Consort diagram of studies included in the systematic review.....	52
Figure 5: Components of pleasure task: diagram of the three phases - see Appendices 8 and 9 for screenshots of the COP task.....	89
Figure 6: Examples of neutral, physical and social images from the IAPS catalogue.....	91
Figure 7: Diagram of learning phase of the COP task	92
Figure 8: Consort diagram of learning phase development pilot study	94
Figure 9: ESM questionnaire: items and branching (see Appendix 12 for screenshots of questionnaire items).....	100
Figure 10: PsyMate device	102
Figure 11: Experience sampling protocol overview.....	104
Figure 12: Diagram illustrating the participation in different stages of the thesis research	111
Figure 13: Study protocol: Session 1.....	119
Figure 14: Schematic diagram of the COP task.....	141
Figure 15: Example of four images selected for learning and anticipatory phases	153
Figure 16: Mean consummatory ratings (error bars represent 1 standard error)	158
Figure 17: Mean anticipatory-consummatory valence discrepancy scores for each category of image; error bars represent 1 standard error	160
Figure 18: The average percentage of questionnaires completed at each beep (1-7) during the experience sampling week	172
Figure 19: The average number of questionnaires completed on each day (1-6) during the experience sampling week.....	173
Figure 20: Section of the TEP model proposing the stages between anticipation and activity	177

Figure 21: Proportion of time-points selected in each activity across the whole ESM week	185
Figure 22: A summary diagram of the relationships between variables at the same time-point (Models 7 and 8) and predictors of activity (Model 9)	194
Figure 23: Proportion of beeps occurring when alone, with familiar or unfamiliar company	195
Figure 24: Influence of context on social anticipatory pleasure for being alone or with familiar people at the same time-point in people with schizophrenia and controls ($p < .05$). F= Familiar β coefficient, A= Alone β coefficient	198
Figure 25: Scatterplots of mean COP task and ESM functional anticipatory ratings with a regression line fitted in both groups	211
Figure 26: Scatterplots of mean ESM and COP task anticipatory social ratings with a regression line fitted	213
Figure 27: The adapted temporal experience of pleasure model	225
Figure 28: The updated temporal experience of pleasure model	227
Figure 29: Q-Q plot control group consummatory neutral valence	300
Figure 30: Q-Q plot schizophrenia group consummatory social valence	301
Figure 31: Q-Q Plot control group anticipatory social low valence	302
Figure 32: Q-Q plot schizophrenia group anticipatory social low valence	303
Figure 33: Screenshot of ESM mood rating	304
Figure 34: Screenshot of ESM current activity items	305
Figure 35: Screenshot of ESM consummatory pleasure rating	306
Figure 36: Screenshot of ESM anticipatory activity categories	307
Figure 37: Screenshot of ESM anticipatory pleasure rating	308
Figure 38: Screenshot of ESM expectation rating	309

Table of Tables

Table 1: Negative symptom items included in the PANSS, BPRS and SANS	30
Table 2: Items included in the expressive and experiential subscales of the CAINS.....	32
Table 3: Measures of anhedonia in schizophrenia	53
Table 4: Studies examining the relationship between emotional memory and anhedonia ...	56
Table 5: Studies assessing the relationship between neurocognition and anhedonia	61
Table 6: Methodologies utilised in the assessment of anticipatory and consummatory pleasure.....	83
Table 7: The standard ratings (9-point Likert scales) from the IAPS list for the three different types of image included in the study.....	91
Table 8: The preliminary pilot valence and arousal ratings (9-point Likert scales) for the 90 images included in the study	93
Table 9: Full pilot and standard consummatory valence and arousal ratings (9-point Likert scales).....	95
Table 10: Average agreement scores for each statement in the experience sampling feasibility questionnaire. Each item was rated on a 7-point Likert scale from 1 (not at all) to 7 (very much so).....	106
Table 11: Characteristics of the full sample.....	132
Table 12: TEPS self-report measure in both groups	133
Table 13: Correlation matrix between TEPS subscales and positive and negative affect scale (PANAS)	134
Table 14: Correlation matrix between TEPS subscales and negative symptom measures ...	134
Table 15: COP task sample characteristics	143
Table 16: Response times during COP task	145
Table 17: A correlation matrix of COP task and self-reported anticipatory and consummatory ratings in the control group	146
Table 18: Categories of ratings entered into analyses	153
Table 19: Pearson correlation coefficients between symptom measures, functioning, medication and ratings in schizophrenia group; V= valence, A = arousal	157
Table 20: Mean (SD) anticipatory and consummatory ratings used to calculate the discrepancy scores for each category	159

Table 21: Categorisation of items in the experience sampling feedback questionnaire; all items rated from 1 (not at all) to 7 (very much so)	168
Table 22: ESM sample characteristics.....	171
Table 23: Mean ESM ratings for each group averaged across the 6 study days	186
Table 24: Multi-level models of between-group differences in positive and negative affect	187
Table 25: Multi-level models of between-group differences in consummatory pleasure, anticipatory pleasure, expectation and motivation	188
Table 26: Multi-level models of the association between current mood and enjoyment and anticipatory ratings	191
Table 27: Variation Partition Coefficients (VPCs) at participant, day and residual levels for each outcome variable in the multi-level linear models estimated	193
Table 28: Multi-level model of time-lagged predictors of future activity	194
Table 29: Multi-level models of between-group differences in social consummatory pleasure, anticipatory pleasure and preference to be alone/with others	196
Table 30: Correlation matrix between interview symptom measures (PANSS and CAINS) and ESM ratings of consummatory pleasure, anticipatory pleasure, expectation and motivation	199
Table 31: Correlation matrix of TEPS and ESM anticipatory and consummatory ratings	209
Table 32: A graphical representation of the identified associations between the three paradigms.....	214

Acknowledgements

Firstly I would like to thank Til Wykes for giving me the opportunity to work in her team and design a project based on my ideas. This thesis would be far poorer without her huge investment of time and effort and I am very grateful for all of her guidance over the past four years. I would also like to thank Nick Tarrier for always providing an alternative perspective on my work and helping me to see the bigger picture. And, of course, a huge thanks to Matteo Cella who has helped me to become a better researcher in so many ways. We have had some fun times at conferences as well as some pretty complicated discussions about the difference between anticipating and experiencing pleasure- I will cherish all of these memories from my PhD. I would also like to acknowledge the financial support I received from the Medical Research Council, UK in the form of a PhD studentship and the NIHR Biomedical Research Centre at the South London and Maudsley NHS Trust and King's College Hospital.

I would like to thank Richard Emsley for giving up his time to patiently explain multi-level modelling and answer my *many* questions throughout my analyses. Andy Brand was so helpful in the development of the COP task and always took the time to explain where his suggestions came from resulting in a much deeper consideration of the detail than I would have managed by myself- many thanks to him too. I would like to thank all my colleagues and friends who either patiently sat through up to 120 pictures or carried around a device which constantly beeped at them to help me out. A huge thank you goes to all the research workers, clinical study officers, PhD students and MSc students who helped me to recruit people for my study. Thanks also to Ulrich Reininghaus and the researchers at Maastricht University for their input in the development of my experience sampling study and taking the time to answer a lot of questions. Thanks to Geraldine for organising everybody's schedules and being so patient with all my emails and questions.

Nina- thanks for always being on hand to solve my problems as my personal emotional resilience tool-kit, as well as helping to foster my love for South East London. Sarah Swan- from day one you were always so supportive and confident in my abilities to finish this, and often a hilarious distraction, thank you! Toby Wise, Tobes, I don't know what I would have done without 12.30 lunches in the Maudsley (or outside!), football and post-

supervision drinks- thanks! Christina, or should I say X-Tina, you have been a breath of fresh air, constantly making me laugh and always ready to do the next fun thing or deal with the next crisis- thank you for being a real-life salsa lady. To ALL the occupants of office 4.04; David Baumeister, Sarah Jensen, Nicole Perkins, Bosiljka Milosavljevic and Azam Yunus this really felt like a team effort at times and it takes a special group of people to generate that atmosphere- thank you so much. Special mention goes to Baumeister, my next-desk neighbour, for his careful monitoring of my grammar and self-esteem. I wish all of you the best of luck and look forward to celebrating some more PhDs in the very near future!

I would like to thank all the residents (past and present) of Amersham Road; I have felt so lucky to have a home full of friends waiting for me every evening as well as the constant reminder of life outside of PhD-world. Thank you for putting up with all my PhD ups and downs, listening to me practice my talks and being so pleased for me when things go well- this really does feel like the end of an era! I also want to thank my siblings; Miles, Theo and Verity for their constant over-achievements in subjects that aren't psychology (thanks for letting me have this one guys!) and perhaps more importantly their unquestioning belief in my ability to achieve what I set out to do- I rely on your faith in me more than you think! I would never have set out on this path if it wasn't for my Mum. Thank you for always telling me I can achieve what I aspire to- I'm glad Clementine came in useful in the end! Thanks Mum, for always being an inspiration and your constant support (emotional and grammatical!) in my endeavours- no matter how baffled you are by them!

Ottilie, Otts, what to say! I can't imagine having done this without you! Thank you for always being there, whether it's reading my work, going out to celebrate or being a voice of reason on the end of the phone. You mean the whole world to me.

Owen, thank you for encouraging me to persevere with beer and coffee all those years ago- I have needed both a lot during this PhD! Thanks for making me macaroni cheese and buying me egg custard tarts. Thanks for helping me deal with the big things and get past the little things. Thanks for often being a rock in a storm (I'm the storm in that scenario) and always believing in me. We make a pretty good team.

And, finally, thank you to all the participants, without whom none of this would have been possible.

Chapter 1: Introduction

“I stopped caring about going to the pub or playing football at the weekends. All I wanted to do was sleep. Conversations were too much hard work.” (Smith, 2014).

The ability to derive pleasure from activities is a key part of the human experience; it has positive effects on an individual's mood and increases their motivation to engage with the world around them (Foussias et al., 2011; Frederickson, 2001). Hence any difficulty engaging with pleasurable experiences is likely to lead to reduced activity levels and social isolation as described in the quote above. A loss of pleasure is termed “anhedonia” and is a symptom of many mental health conditions e.g. borderline personality disorder, mood disorders, Parkinson's disease, schizoaffective disorder and schizophrenia. The consequences of anhedonia are far-reaching with a lack of enjoyment from life often resulting in hobbies being abandoned, social ties being cut and resistance to engaging in new activities. This can contribute to a large reduction in quality of life. Despite the negative impact of anhedonia, there are currently no interventions targeted at this problem. One explanation for the delay in developing treatment may be the lack of clarity in the definition of anhedonia and how it can be targeted therapeutically. This thesis will examine anhedonia in people with schizophrenia specifically, with the aim of developing better measures to address this problem. The research questions that are investigated are part of the process of identifying potential targets for future interventions. Alongside a detailed review of the literature regarding anhedonia, this chapter will introduce relevant concepts that will help to contextualise the research questions of this thesis.

1.1 Schizophrenia

The term “psychosis” is used to describe a combination of abnormal thoughts (delusions) and unusual sensory experiences (hallucinations) also termed the “positive symptoms” of schizophrenia. Research in the last decade has revealed these experiences to be more prevalent than originally thought. Sub-clinical psychotic experiences occur in 5-6% of the population (van Os, Linscott, Myin-Germeyns, Delespaul, & Krabbendam, 2009) and the lifetime prevalence of psychotic disorders is estimated at 1.5-3% (Perala et al., 2007; van

Os, Hanssen, Bijl, & Vollebergh, 2001). Schizophrenia is the most common psychotic disorder (Perala et al., 2007) and is characterised by psychotic or “positive” symptoms alongside “negative” symptoms which include low motivation, anhedonia, social withdrawal and blunted affect. The other symptom cluster present in people with schizophrenia is disorganisation, which has been conceptualised as specific difficulties with neurocognition and social cognition (Reichenberg, 2010; Savla, Vella, Armstrong, Penn, & Twamley, 2013). The age of onset of schizophrenia is usually between 18 and 30 years, striking at a crucial stage in life when many relationships are formed and careers begin. The demographics of the illness show that there is a higher prevalence in men (Aleman, Kahn, & Selten, 2003; Gelber et al., 2004). Schizophrenia is one of the top 10 leading causes of disability in developed countries (C. J. L. Murray & Lopez, 1996) and affects 1% of the population (approximately 51 million people worldwide) (Perala et al., 2007). In England alone the estimated cost of this illness to society is £11.8 billion with a public sector cost of £7.2 billion (The Schizophrenia Commission, 2012). The prognosis of people with a diagnosis of schizophrenia is variable but in a large proportion of individuals it is difficult to treat and may persist for years (Loas, Azi, Noisette, Legrand, & Yon, 2009). A meta-analysis of over 50 studies found that only 1 in 7 people with schizophrenia met criteria for recovery which included improvements in clinical and social domains that had persisted for 2 years (Jaaskelainen et al., 2013).

The positive symptoms are the main focus of the current diagnostic criteria for schizophrenia in both of the main diagnostic systems: the ICD-10 (World Health Organisation, 1992) and DSM-V (American Psychiatric Association, 2013). Experiencing auditory hallucinations (critical voices or a running commentary) or delusions for longer than one month is sufficient to receive a diagnosis in either system. This emphasis on positive symptoms in the diagnostic systems is in contrast to the approach taken by some researchers over the last decade. As increasing numbers of studies showed that positive symptoms were not related to functional outcomes, the focus of research changed to other symptom clusters such as negative symptoms and cognition which have emerged as important predictors of long-term functioning (Bowie, Reichenberg, Patterson, Heaton, & Harvey, 2010; Menendez-Miranda et al., 2015).

The contribution of functional outcomes to the wider concept of recovery has been examined in the literature. Indeed, service users have identified functional outcomes as more central to recovery than symptom reduction (P. D. Harvey, 2009; Rose, 2014). In the recent report from The Schizophrenia Commission (2012), service users identified support from family and friends, stable housing and help finding a job as well as the independence provided by self-management strategies as important factors in recovery. One service user described her experience and emphasised the importance of social support in this report: *“Psychosis is very painful and very strange. People don’t understand you and find you difficult to be with. The most healing thing is others’ acceptance, love and kindness. I don’t think friends realised what it was like. Nobody called me when I was out of crisis to see that I was better.”* The Commission also found that only 8% of people with a diagnosis of schizophrenia were in work but many more wanted to be in employment (The Schizophrenia Commission, 2012).

The concept of recovery can be difficult to define, but studies conducted in the literature have more recently focused on functional outcomes and the symptoms that contribute to these rather than positive symptom reduction alone, reflecting the priorities of service users (P. D. Harvey, 2009; Rose, 2014).

1.1.1 Factors Influencing Functional Outcomes in People with Schizophrenia

A key functioning domain where people with schizophrenia have pronounced difficulties is work. Research has showed that poor cognition or thinking skills is one of the most significant barriers to employment (Strassnig et al, 2015). Reduced cognitive abilities are consistently reported in people with this diagnosis including those who are medication-naïve (Fatouros-Bergman, Cervenka, Flyckt, Edman, & Farde, 2014; Schaefer, Giangrande, Weinberger, & Dickinson, 2013). Social cognition - the mental operations that underlie interactions with other people - has also been shown to be reduced in people with schizophrenia and those determined to be at “clinical high risk” of developing the disorder (T. Y. Lee, Hong, Shin, & Kwon, 2015; Savla et al., 2013). Both social-cognitive and neurocognitive difficulties have been shown to be strongly linked to poor functioning in everyday life in people with schizophrenia (Allott, Liu, Proffitt, & Killackey, 2011; Reichenberg et al., 2014). However, negative symptoms have been consistently shown to be

a more significant predictor of poor functional outcomes than either social cognition or neurocognition (Berenbaum, Kerns, Vernon, & Gomez, 2008; Marchesi et al., 2015). The link between neurocognition, social cognition and functioning has driven the development of targeted interventions and several studies show that cognitive remediation therapy (CRT) and social cognitive remediation therapy (SCT) are effective in their treatment of these difficulties (Roberts et al., 2014; Wykes, Huddy, Cellard, McGurk, & Czobor, 2011). The same link has been consistently reported between negative symptoms and functioning, yet this targeted intervention approach has not been employed concerning these difficulties (Keefe, 2014).

Initial findings suggest that intervening early in these difficulties may be more important to promote good functional outcomes for individuals with a diagnosis of schizophrenia (Bartholomeusz & Allott, 2012). A recent longitudinal study found that both social and occupational functioning are reduced when an individual experiences their first episode of schizophrenia, and decline from that point with more severe negative symptoms predicting worse outcome (Marchesi et al., 2015). Indeed, negative symptoms are associated with poor social functioning, work/school functioning and real-world functioning and therefore are an important factor in determining the prognosis of an individual with schizophrenia (Menendez-Miranda et al., 2015; Robertson et al., 2014; Rocca et al., 2014; Ventura et al., 2015). A recent review identified negative symptoms as having a larger impact on functioning than other symptom domains in those individuals experiencing the at-risk mental state (Cotter et al., 2014). The next section will review the progress made in understanding these negative symptoms over the last five decades.

1.2 Negative Symptoms

Negative symptoms are generally defined as blunted affect, low motivation, avolition, social withdrawal, anhedonia and apathy. The link between negative symptoms and functioning described in the previous section was first identified in the early descriptions of “dementia praecox” by Kraepelin (1971/1919) as *“a weakening of those emotional activities which permanently form the mainsprings of volition,”* resulting in *“emotional dullness, failure of mental activities, loss of mastery over volition, of endeavor,*

and of ability for independent action." Kraepelin conceptualised this lack of emotional expression and motivation as the result of an inability to experience emotional states. In his writings, the reduced facial expressions, gestures and speech were assumed to be an accurate reflection of the individual's internal emotional experience (Kring, Kerr, Smith, & Neale, 1993). Kraepelin also wrote about an essential link between pleasure and activity: *"In normal life the performance of mental and physical work is accompanied by a feeling of pleasure. The basis for this experience lies in the fact that the formation and maintenance of personality depends upon activity"* (Kraepelin, 1981/1904). Therefore, he proposed that a fundamental inability to experience pleasure underlies the social and functional deficits often reported by people with schizophrenia. Although the concept of anhedonia or an "inability to experience pleasure" has changed substantially over the years, the link between emotional deficits and lack of activity has been consistently reported since it was posited by Kraepelin (Marchesi et al., 2015).

Eugen Bleuler also highlighted emotional and motivational deficits as an important group of symptoms in what he termed "schizophrenia" for the first time: *"indifference seems to be the external sign of their state...The will...disturbed in a number of ways, but above all by the breakdown of the emotions. The patients appear lazy and negligent because they no longer have the urge to do anything either of their own initiative or at the bidding of another"* (Bleuler, 1950/1908). The clinical descriptions of negative symptoms from his writings are similar to those of Kraepelin, but Bleuler made a very different interpretation of his observations. He found that people with schizophrenia consistently reported intense emotional experiences, but these were never reflected in reports from relatives, friends or clinicians. Rather than assuming an underlying inability to experience emotion Bleuler wrote *"Thus there can be no doubt at all that the psyche's capacity to produce affects has not disappeared in schizophrenia"* (Bleuler, 1950/1908). His opinion was that people with schizophrenia had an intact ability to experience emotion but that the connections from these emotions to thoughts, volition and expression had broken down (Messinger et al., 2011). Bleuler further hypothesised that the internal experience of emotions was intact, but due to loose associations between different parts of the psyche, people with schizophrenia could not communicate this experience or express it. Bleuler was also one of the first people to draw distinctions between different groups of symptoms within schizophrenia. He

distinguished primary symptoms which were the core pathological processes e.g. loosening of associations, affective blunting, ambivalence, from secondary symptoms e.g. hallucinations, delusions, stupor which were the responses of intact psychological systems to these pathological processes (Malaspina et al., 2014).

These clinical descriptions and interpretations of the emotional deficits in schizophrenia remained the most detailed writings on this subject for nearly 50 years. They were not investigated further for decades as in the 1950s the emphasis was directed to positive symptoms by Kurt K. Schneider (1959). In his influential work he described so-called “first rank symptoms”, which are fundamental illness features, as hallucinations and delusions. This was shortly followed by the development of the first anti-psychotic medications. These events led to a significant focus on hallucinations and delusions and little progress in the understanding or treatment of emotional and expressive deficits in schizophrenia. This is reflected in the DSM-III (American Psychiatric Association, 1980), where the diagnostic criteria for schizophrenia were grounded in Schneiderian first rank symptoms with researchers deeming the classification of negative symptoms too unreliable for inclusion in the criteria (Malaspina et al., 2014).

Indeed, reliable negative symptom descriptions and classification only appeared in the 1970s, quite late in the field of schizophrenia research. The terms “positive” and “negative” symptoms had been used in neuropsychiatry before the identification of schizophrenia, initially by James Russell Reynolds (Reynolds, 1861) in his description of epilepsy. In his writings negative symptoms were described as the loss of vital properties resulting in anaesthesia or paralysis. Positive symptoms on the other hand were considered an excess of vital properties resulting in spasms, pain or convulsions. The first person to apply the terminology of positive and negative symptoms to schizophrenia was a Soviet psychiatrist named Snezhnevsky (1968). This was extended and consolidated by J. S. Strauss, Carpenter, and Bartko (1974) who described three clusters of symptoms within schizophrenia: positive, negative and disorganised. Thus the definitions of positive and negative symptoms in schizophrenia remain grounded in their 19th century origins; positive symptoms are additional or altered experiences (hallucinations, delusions) and negative symptoms are deficits or reductions in behaviours or experiences compared to a hypothetical “normal” profile (e.g. low motivation, reduced facial expressions, low

pleasure). Researchers utilised this new terminology with enthusiasm, and in the 1980s research began to expand beyond positive symptoms to focus on describing and understanding negative symptoms. As a result the DSM-III-R (American Psychiatric Association, 1987) included *flat affect* in its diagnostic criteria for schizophrenia and *avolition* in the prodromal category (Messinger et al., 2011).

Over the last three decades of research, negative symptoms have received much more attention. A National Institute of Mental Health-Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS) consensus defined the negative symptoms of schizophrenia as anhedonia and apathy, avolition and asociality, poverty of speech and blunted affect (Kirkpatrick, Fenton, Carpenter, & Marder, 2006). They appear to be stable throughout the course of the illness at 1yr and 13yr follow-up points (Blanchard, Horan, & Brown, 2001; Loas, Monestes, Ingelaere, Noisette, & Herbener, 2009). The current diagnostic criteria for schizophrenia in DSM-V (American Psychiatric Association, 2013) and ICD-10 (World Health Organisation, 1992) describe the negative symptoms as “affective flattening, avolition, apathy” and the ICD-10 includes social withdrawal. It is not necessary to exhibit negative symptoms to receive a diagnosis of schizophrenia in either diagnostic system and they are considered less definitive than the positive symptoms (e.g. hallucinations, delusions). However, there has been a growing realisation that negative symptoms are the “elephant in the room” when it comes to recovery from the disorder. As described previously, a reduction in positive symptoms is not considered sufficient for personal recovery by service users (Rose, 2014) and instead many factors limited by negative symptoms e.g. social support, employment and self-management are identified as more important (Jose et al., 2015). Indeed, the impact of anti-psychotic medication on quality of life has been shown to be limited and independent of a reduction in symptoms (Fervaha, Agid, Takeuchi, Foussias, & Remington, 2014). A service user blog exemplifies the difficulties in coping with the negative symptoms of schizophrenia and the impact they have on quality of life:

“For the past six years, my psychiatrist was able to get the positive symptoms under control with Risperdal 3mg but my quality of life was just not as good as it could be and I realized this after a relapse in 2013. I had just accepted this way of life until I began researching this disorder more. I have since been trying various antipsychotics to help me with the negative

symptoms, mainly loss of motivation, seeming lack of interest in the world and other people, and the inability to feel pleasure or act spontaneously.

I have been on 80mg of Latuda for one month now and the negative symptoms are diminishing slowly. I am more interested in people again especially my immediate family, am more motivated, am more interested in the world and am starting to feel pleasure again. Before I was dead I feel to emotions but I have been enjoying people more and my hobbies and my work has improved; although, I always work very hard, now it is different. I am more thorough and making more connections increasing my productivity greatly at work and at home.” (Alonso, 2014).

Despite this overwhelming support for negative symptoms as a key therapeutic target there are currently very few specific interventions available (Elis, Caponigro, & Kring, 2013). The treatments available have modest effects at best and many are not effective at all (Fusar-Poli et al., 2014).

1.3 Measurement of Negative Symptoms

1.3.1 The Need for Reliable Measures

To tackle this lack of effective interventions for negative symptoms, it became imperative to develop reliable measures of these difficulties to serve as outcome measures in clinical trials. Negative symptoms are inherently difficult to assess using self-report interviews or questionnaires due to their definition which is grounded in deficits and absent behaviours. To quantify an absence of a behaviour or experience is challenging and can be more susceptible to interviewer bias than establishing the presence or frequency of an additional, unusual experience such as hearing voices. “How often have you heard voices in the last week?” is a common question used to assess the severity of hallucinations. This generates a more reliable response and requires little or no interpretation from the interviewer compared to “how often have you *lacked* motivation in the last week?” The latter question may produce a more ambiguous response, particularly as a concept such as motivation or pleasure is less discrete than the occurrence of a hallucination. The measurement of missing or reduced behaviours also relies on an understanding of what is normal for that individual which may be challenging for the interviewer. On the other hand,

the occurrence of unusual experiences such as hallucinations and delusions can be more reliably considered as abnormal by the interviewer. The other issue is the aetiology of the negative symptoms being assessed. Social withdrawal, for example, may be present as a fundamental negative symptom of schizophrenia; however it could also be present in individuals with this diagnosis due to social anxiety, co-morbid depression, institutionalisation, command hallucinations, paranoia or extra-pyramidal side-effects from antipsychotic medication (E. C. Brown et al., 2014; Lowengrub, Stryjer, Birger, & Iancu, 2015; Schennach et al., 2015).

1.3.2 Aetiology of Negative Symptoms

Carpenter, Heinrichs, and Wagman (1988) drew a distinction between primary negative symptoms, present as an element of the disorder, and secondary negative symptoms which are present in response to another factor. Whilst this is an important distinction to be aware of, distinguishing primary from secondary negative symptoms is problematic and relies heavily on a longitudinal approach and historical accuracy, both of which can be impractical and use information that is difficult to obtain (Messinger et al., 2011). This distinction has not been applied extensively in research or clinical practice due to these limitations. It has however raised awareness of negative symptoms as primary symptoms of the disorder, rather than only being present only as a result of co-morbid depression or extra-pyramidal symptoms. The prevalence of motivational deficits independently of medication has also been confirmed in research (Fervaha, Takeuchi, et al., 2015). Better assessment tools are needed to enable the primary and secondary negative symptoms distinction to be applied in clinical and research settings (Kirkpatrick, 2014).

1.3.3 Are Negative Symptoms Related to Depression?

Negative symptoms were often considered to be present due to co-morbid depression and anti-depressant medication was prescribed as a result. However, factor analytic studies have demonstrated that anhedonia loads onto a negative symptom factor and not a depressive symptom factor in people with schizophrenia in both 3- and 5-factor solutions (Andreasen, 1982; Blanchard & Cohen, 2006; John, Khanna, Thennarasu, & Reddy,

2003). Although one small, and therefore less robust, study reported anhedonia loading onto a depressive not a negative symptom factor (Romney & Candido, 2001). Studies have reported correlations between anhedonia and depressive symptoms (Chaturvedi, Rao, Mathai, Sarmukaddam, & Gopinath, 1985; Kollias et al., 2008; Sax et al., 1996) but larger, more robust studies found no correlation (Blanchard et al., 2001; Sarkar, Praharaj, Chaudhury, & Das, 2010). The longitudinal study by Blanchard et al. (2001) found social anhedonia (reduced enjoyment of being with others) to be more stable in individuals with schizophrenia than those with depression over a 1yr period, suggesting that the nature of this symptom differs between the two disorders. This is supported by two studies which found that self-reported anhedonia shows different associations with impulsivity and behavioural activation in bipolar disorder and major depression compared to schizophrenia (Amr & Volpe, 2013; Tso, Grove, & Taylor, 2014).

1.3.4 Current Measures of Negative Symptoms

Current measures used to assess negative symptoms do not draw a primary vs. secondary distinction and rarely include items concerning the aetiology of the negative symptoms. This emphasises negative symptoms as a key feature of the illness but may miss opportunities to treat other contributing factors such as extra-pyramidal symptoms or social anxiety. The most commonly used measures of negative symptoms were developed approximately 30 years ago; the Positive and Negative Syndrome Scale (PANSS) (Kay, Fiszbein, & Opler, 1987), Brief Psychiatric Rating Scale (BPRS) (Overall & Gorham, 1962) and Scale for the Assessment of Negative Symptoms (SANS) (Andreasen, 1982) (see Table 1). These interviews are conducted by trained researchers who ask questions in order to gather information that will allow them to rate the severity of each item for that individual. In the PANSS and BPRS the items are rated from 1 (absent) to 7 (very severe). In the SANS each item is rated from 0 (absent) to 5 (severe). These scales all take a comprehensive approach to the measurement of negative symptoms, but replication of the original symptom factors has been problematic. Exploratory factor analyses have shown that items in the SANS: inappropriate affect, inattention and poverty of content of speech, do not load onto a negative symptom factor and are more appropriately grouped in a disorganisation factor (Earnst & Kring, 1999). The negative symptom cluster in the PANSS has also been difficult to

replicate in factor analyses with results showing that a four or even five-factor solution e.g. excited, positive, negative, depression/anxiety and disorganised/cognitive, is the best fit for this scale (Lindenmayer, Grochowski, & Hyman, 1995; Messinger et al., 2011; Van den Oord et al., 2006; Wallwork, Fortgang, Hashimoto, Weinberger, & Dickinson, 2012). The items included in the “negative symptom subscale” of the BPRS also show wide variability which adds to the inconsistency in the field (Nicholson, Chapman, & Neufeld, 1995). The items most consistently included in these scales are detailed in Table 1 below.

Table 1: Negative symptom items included in the PANSS, BPRS and SANS

Negative Symptom Items							
PANSS (7 items) (Kay et al., 1987)	Emotional Withdrawal	Passive/Apathetic Social Withdrawal	Blunted Affect	Difficulty with Abstract Thinking	Lack of spontaneity and flow of conversation	Poor Rapport	Stereotyped thinking
SANS (5 subscales, 30 items) (Andreasen, 1982)	Anhedonia-Asociality <ul style="list-style-type: none"> Recreational Activities/Interests Sexual Interest/Activity Ability to feel intimacy Relationships with friends/peers Subjective awareness of anhedonia-asociality = Global Rating of Anhedonia-Asociality	Affective Flattening <ul style="list-style-type: none"> Unchanging facial expression Decreased spontaneous movements Paucity of expressive gestures Poor eye contact Affective non-responsivity Inappropriate affect Lack of vocal inflections Subjective rating of affective flattening = Global Rating of Affective Flattening	Attentional Impairment <ul style="list-style-type: none"> Work inattentiveness Inattentiveness during mental status testing Subjective complaints of inattentiveness = Global rating of Inattentiveness	Alogia <ul style="list-style-type: none"> Poverty of speech Poverty of content of speech Blocking Increased latency of response Subjective rating of alogia. = Global rating of Alogia	Avolition-Apathy <ul style="list-style-type: none"> Grooming and hygiene Impersistence at work/school Physical anergia Subjective complaints of avolition-apathy = Global rating of Avolition-Apathy		
BPRS (3 items) (Overall & Gorham, 1962)	Emotional Withdrawal	Blunted Affect	Motor Retardation				

1.3.2 Distinctions Within Negative Symptoms

1.3.2.1 *Expressive vs. Experiential Deficits*

A limitation of scales such as the BPRS, PANSS and SANS is that they produce a single negative symptom score across all of these subscales which combines the expressive deficits (reduced gestures, speech and facial expressions) and experiential deficits (amotivation, asociality, anhedonia) (Keefe et al., 1992; Messinger et al., 2011). This may have contributed to the difficulty in replicating the original negative symptom factors in these scales, as the symptoms included are highly heterogeneous and therefore perhaps unreliable (Liemburg et al., 2013). It became apparent that by combining both groups of symptoms to form one score, the severity of the *experiential* deficits (reduced emotional experience, apathy) was being confounded with the individual's reduced *expression* of emotion (Blanchard & Cohen, 2006; Kirkpatrick, 2014). Indeed, factor analyses of both the PANSS and SANS have identified that the items included in these scales load onto these two distinct factors (Liemburg et al., 2013; Lyne et al., 2013; Messinger et al., 2011). The field has progressed by incorporating a distinction between expressive and experiential symptoms into new measures. The Clinical Assessment Interview for Negative Symptoms (CAINS) (C. Forbes et al., 2010; Kring, Gur, Blanchard, Horan, & Reise, 2013) was devised to assess these sub-domains in negative symptoms. A structural analysis confirmed the items of this scale reliably load onto two factors: experiential and expressive (Horan, Kring, Gur, Reise, & Blanchard, 2011). These two factors have been confirmed in a validity study of the CAINS (self-report) (Lyne et al., 2013; S. G. Park et al., 2012). However, a recent systematic review identified the CAINS expressive subscale as having a low internal consistency score in the assessment of blunted affect (Kilian et al., 2015) suggesting that this subscale may require further replication and development. The items included in the experiential and expressive subscales are listed in the table below (see Table 2). The Brief Negative Symptom Scale (BNSS) (G. P. Strauss, Keller, et al., 2012) was also introduced to measure experiential and expressive deficits separately and the validity of this approach was confirmed in a factor analysis of this scale (G. P. Strauss, Hong, et al., 2012). However, the BNSS has largely been used by the same experimental group and has not been as widely validated as the CAINS.

Although it is common for individuals to experience both experiential and expressive symptoms, and studies report moderate correlations between the subscales of the CAINS, evidence suggests it is more valid to measure them separately (Horan et al., 2011). The CAINS is still susceptible to interviewer bias but overcomes some of the difficulties in assessing negative symptoms by measuring the frequency of an activity separately from internal emotional experience and motivation to engage in that activity. This is an improvement on previous scales in which these were often combined to form a single score. Experiential negative symptoms such as anhedonia and amotivation have been shown to have a larger impact on functioning than expressive negative symptoms and may therefore represent an important potential therapeutic target (Fervaha, Foussias, Agid, & Remington, 2013; Foussias et al., 2011; Saperstein, Fiszdon, & Bell, 2011).

Table 2: Items included in the expressive and experiential subscales of the CAINS

CAINS Expressive Subscale	CAINS Experiential Subscale
Vocal Prosody	Social <ul style="list-style-type: none"> • Expected pleasure • Past-week pleasure • Family relationships • Friends
Facial Expressions	Recreation <ul style="list-style-type: none"> • Expected pleasure • Past-week pleasure • Motivation
Gestures	Vocational <ul style="list-style-type: none"> • Expected pleasure • Motivation
Speech	

1.3.2.2 Anhedonia in Schizophrenia

Within the experiential deficits anhedonia is generally defined as *a reduced ability to experience pleasure* and is often considered to be closely linked to low motivation to engage in activities. Anhedonia and amotivation have been shown to be stable traits which persist independently of changes in other negative symptoms, positive symptoms or cognitive deficits (Berenbaum et al., 2008; Loas, Monestes, et al., 2009). Anhedonia has also been shown to predict transition to a diagnosis of schizophrenia in an ultra-high risk population, suggesting that it may be important in the development of the disorder (Velthorst et al., 2009). Anhedonia and amotivation appear early and are stable over time mirroring the nature of the functional deficits in people with schizophrenia which are strongly linked to both anhedonia and amotivation (Fervaha, Foussias, Agid, & Remington, 2015; Ventura et al., 2015). This suggests that these symptoms present a barrier to returning to work and maintaining social capital and should be a priority in future research (Keefe, 2014).

1.3.2.3 Social Anhedonia

The increased interest in distinctions within negative symptoms and differing impacts on functioning has led to the consideration of social-specific deficits in people with schizophrenia. Historically, there has been some suggestion that people with schizophrenia experience social anhedonia, which is more severe than emotional deficits, related to non-social activities (Cohen, Najolia, Brown, & Minor, 2011). Scales assessing anhedonia have been developed that measure social pleasure separately from pleasure experienced during non-social activities (Chapman et al, 1976). These have shown that social anhedonia is associated with poor functioning in people with schizophrenia spectrum disorders (Brosey & Woodward, 2015). The Chapman social and physical anhedonia scales have been used extensively and show that both social and non-social anhedonia can be high in people with schizophrenia but may have differing profiles (Tso et al., 2014). For example, social anhedonia may be high in an individual but physical anhedonia may not be or vice versa (Ritsner, 2013). A recent large study found that social anhedonia was similarly elevated in both people with high schizotypy and those with a diagnosis of schizophrenia but that

physical anhedonia was higher in the schizophrenia group (Y. Wang et al., 2014). Mixed findings have been reported in the laboratory setting. A recent study found that negative symptoms were associated with lower arousal ratings to unpleasant *social images only* in people with schizophrenia although responses did not differ to social vs. non-social images overall (Bodapati & Herbener, 2014). A meta-analysis of pleasure ratings in response to images also reported similar positive emotion ratings of social stimuli in people with schizophrenia and people without mental health problems (Cohen & Minor, 2010).

Although the nature of any specific social deficits is unclear, there is evidence to suggest that trait social anhedonia may be present independently of trait physical anhedonia, and this distinction is reflected in the newest measures of negative symptoms. It is also an important consideration for future studies since a failure to control for the level of social content may introduce bias in the stimuli selected.

1.3.3 The Use of Experimental Paradigms in the Assessment of Pleasure

As well as traditional self-report measures, experimental paradigms have been developed which measure different components of negative symptoms. These have advantages over self-report measures: specifically the lack of interviewer bias and the ability to manipulate the paradigm to target specific processes and examine the responses of an individual to carefully selected stimuli. Computer analyses assessing expressive negative symptoms through speech inflection and production have been conducted using available acoustic and lexical-analytic software (Cohen, Alpert, Nienow, Dinzeo, & Docherty, 2008). However, due to their strong links with functional outcomes, assessments of experiential negative symptoms, i.e. motivation and pleasure, have comprised much of the task development in this field. The experimental field is very heterogeneous with components of experiential negative symptoms assessed so far including pleasure experienced in direct response to stimuli, anticipation of reward, motivation and willingness to exert effort (Kring & Barch, 2014; G. P. Strauss, Waltz, & Gold, 2013). Many of the tasks used in this field have been adapted from the reward processing literature. This is because some researchers have conceptualised self-reported anhedonia as either a reward processing or a learning deficit, both of which have been well documented in people with schizophrenia (Gold, Waltz,

Prentice, Morris, & Heerey, 2008). The most commonly used task to assess reward processing in the anhedonia literature is the monetary incentive delay task (G. P. Strauss et al., 2013). In this task, participants learn that certain cues are rewarding and are asked to respond to those cues as quickly as possible in order to obtain a reward (Knutson, Fong, Adams, Varner, & Hommer, 2001). They are then given feedback on whether they obtained the reward or not. The task design separates reward anticipation (viewing the cue) from the reward receipt (feedback).

Experimental tasks have the potential to illuminate the components which play a role in the broader concepts and experiences assessed in self-report interview and questionnaire measures. However, the usefulness of this approach is dependent on developing tasks which are hypothesis-driven and assess constructs that are relevant to functional outcomes identified as a priority by service users (P. D. Harvey, 2009). The field is in a strong position to do this due to the large body of work conducted in the last two decades but it needs clarification to progress. To this end, the findings from experimental studies are synthesised in a systematic review described in Chapter 2, highlighting clinically-relevant areas for future research.

1.3.4 The Experience Sampling Approach

Experimental tasks may have limited generalisability to everyday life due to the abstract stimuli used and the laboratory setting in which they take place. This concern has driven researchers to establish the validity and feasibility of leaving the laboratory and examine experiences in everyday life using experience sampling methodology (ESM) (Palmier-Claus et al., 2011). This approach involves participants completing questionnaires assessing their internal experiences and behaviours during their everyday lives (Oorschot, Kwapil, Delespaul, & Myin-Germeys, 2009). These questionnaires can be in the form of a booklet and a programmed watch or more recently, measures have been delivered to the participant electronically using personal digital assistants (PDAs) or mobile phones (Kimhy, Myin-Germeys, Palmier-Claus, & Swendsen, 2012; Myin-Germeys, Krabbendam, Delespaul, & van Os, 2004; Palmier-Claus et al., 2012). Many of the symptoms of schizophrenia such as delusions, social withdrawal and low motivation are grounded in the individual's

interactions with their environment. Using ESM to study these interactions between individual and environment is therefore a highly valid method of assessment (Oorschot et al., 2009).

The first ESM study in schizophrenia was a case study. This study aimed to gain an understanding of a woman's everyday experience of her symptoms to provide the clinicians involved in her care with an insight into her difficulties in everyday life (Hurlburt & Melancon, 1987). She was signalled through a small earpiece up to 10 times a day and asked to stop what she was doing and write down her internal experiences (thoughts and emotions) at that moment. She then discussed these descriptions with the researchers daily. The majority of her reports gave visual descriptions of her environment which were slightly distorted. These distorted images did not shock or surprise the participant when she reviewed her descriptions with the researchers. Thus, the researchers concluded that she accepted these perceptions and they could be having an effect on her daily life and behaviour (Hurlburt & Melancon, 1987). Recognising the limits and susceptibility to bias of a case study, another experience sampling study was conducted with 11 individuals with psychotic spectrum disorders and 11 controls to examine their positive symptoms, mood and activity levels (Delespaul & deVries, 1987). The findings showed good feasibility of the methodology and that people with psychosis had more extreme emotional reactions to events than controls. People with psychosis also had a different pattern of activity to controls with more time spent "doing nothing".

Researchers were initially concerned about the validity and reliability of the reports from people with schizophrenia regarding their thoughts and emotions. However, several larger studies (Ben-Zeev, McHugo, Xie, Dobbins, & Young, 2012; Granholm, Loh, & Swendsen, 2008; Kimhy, Vakhrusheva, Liu, & Wang, 2014) have followed these initial investigations and report meaningful insight from people with schizophrenia into a range of experiences linked to the disorder, e.g. hallucinations, paranoia, thought suppression and mood (Delespaul, deVries, & van Os, 2002; Thewissen et al., 2011; Udachina, Varese, Myin-Germeys, & Bentall, 2014). The conclusion from this body of research is that experience sampling is a feasible methodology to use to examine experiences in daily life of people with schizophrenia (Kimhy et al., 2012). However, there is room for improvement in establishing the validity of the reports given, particularly regarding the issue of responsivity (Kimhy et al.,

2006). This term refers to a situation where the ESM protocol interferes with the individual's daily life to the point where data are not gathered from a typical week. The degree of responsivity during an ESM week was examined in this thesis. A further potential issue yet to be examined is the impact of negative symptoms and medication levels on completion rates. These factors may represent a barrier to questionnaire adherence and therefore limit the generalisability of the findings to individuals with chronic schizophrenia. The relationships between symptoms, medication and questionnaire completion were also examined in this thesis. ESM data can potentially provide information about the impact and experience of symptomatology in everyday life and also enable service users to report their difficulties without the limitations of memory problems, interviewer bias or lack of relevance to everyday life (Kimhy et al., 2012).

The main contribution of experience sampling methodology to negative symptoms research has been the assessment of emotions experienced during events in everyday life. The initial assumption of Kraepelin (Kraepelin, 1981/1904) that blunted emotional expressions in people with schizophrenia reflected a lack of internal emotional experience has consistently been found to be false using this methodology (McCormick, Snethen, & Lysaker, 2012; Myin-Germeys, Delespaul, & deVries, 2000; Oorschot et al., 2013). Instead, evidence from ESM supports the view of Bleuler who proposed that people with schizophrenia had no deficits in emotional experience (Bleuler, 1950/1908). During everyday life people with schizophrenia consistently report similar positive mood compared to controls and similar pleasure during events, both social and non-social (Gard, Kring, Gard, Horan, & Green, 2007; Gard, Sanchez, Cooper, et al., 2014; Oorschot et al., 2013). ESM has provided insight into emotional experience beyond symptom interviews and experimental paradigms that have changed the way emotional deficits are understood in people with schizophrenia. Although it has many advantages over other methods, ESM requires relinquishing any control over the nature of the environment and the stimuli the individual interacts with, and it is therefore an observational rather than experimental approach. This means the typicality of the week the participant experiences whilst they are taking part in such a study is very important (Kimhy et al., 2012). As mentioned previously, more research is needed on this issue of responsivity during the week and this was one aim of this PhD (see Chapter 7). It is therefore important to place assessments conducted in this manner in the

context of experimental data and traditional self-report interviews and questionnaires which may provide a broader picture of the individual's experience. ESM also offers a validation opportunity for experimental paradigms and self-report measures as their relevance to everyday life experience can be assessed (Oorschot et al., 2009).

1.3.5 Summary of the Current Measures of Negative Symptoms

Negative symptom measures began with a very broad, comprehensive perspective in an attempt to raise the profile of these difficulties and understand their prevalence and impact (Andreasen, 1982; Kay et al., 1987; Messinger et al., 2011). In the decades since the first measures were developed, a more specific approach has been adopted by researchers. It became clear that negative symptoms were not one cluster but at least two; these may have different aetiologies, impacts and predictive values for functioning (Ergul & Ucok, 2015; Fervaha, Foussias, et al., 2015; Rassovsky, Horan, Lee, Sergi, & Green, 2011). This understanding has been reached through the development of new measures which assess these symptoms separately from expressive deficits (Kirkpatrick, 2014; Kirkpatrick et al., 2011; G. P. Strauss, Hong, et al., 2012). The limits of traditional interviews in the assessment of emotional deficits became apparent as research progressed, i.e. retrospective memory problems and the potential confound of activity frequency in the assessment of internal emotional experience. Experimental paradigms were added to these traditional measures to overcome these limitations. These tasks provide detailed assessments of specific processes; the majority of the work has studied pleasure, motivation and reward learning (G. P. Strauss et al., 2013). A synthesis of these findings is needed to progress the field, especially the development of new experimental paradigms. ESM studies have provided valuable insight and confirmed Bleuler's original notion (Bleuler, 1950/1908) that the emotional blunting seen in the expressions, gestures and speech of people with schizophrenia hides an intact ability to experience emotions (Kring et al., 1993). However, it is important to consider the observational nature of experience sampling studies and interpret the findings from these studies alongside those from self-report and experimental paradigms.

All these approaches offer differing but important perspectives on the difficulties faced by people experiencing negative symptoms such as anhedonia and amotivation. In a young field such as experiential negative symptom research it is imperative to continue

integrating findings from different approaches: self-report, experimental and ESM considering their limitations and noting where they complement each other. For example, a self-report questionnaire may be the most appropriate method to assess broader difficulties such as low motivation or to gather long-term information including future goals or the history of the individual's negative symptoms. To understand precise deficits in processes that may be playing a role in a wider difficulty such as social withdrawal or low motivation, an experimental paradigm would be a useful, accurate method to adopt. To gain an understanding of the day-to-day impact of negative symptoms, experience sampling can provide valid, detailed information. All three approaches have been utilised in this PhD and their findings are integrated to capitalise on the strengths of each method and minimise their limitations. The field is beginning to synthesise findings from the data produced using these methodologies into models of experiential negative symptoms and how they impact on functioning.

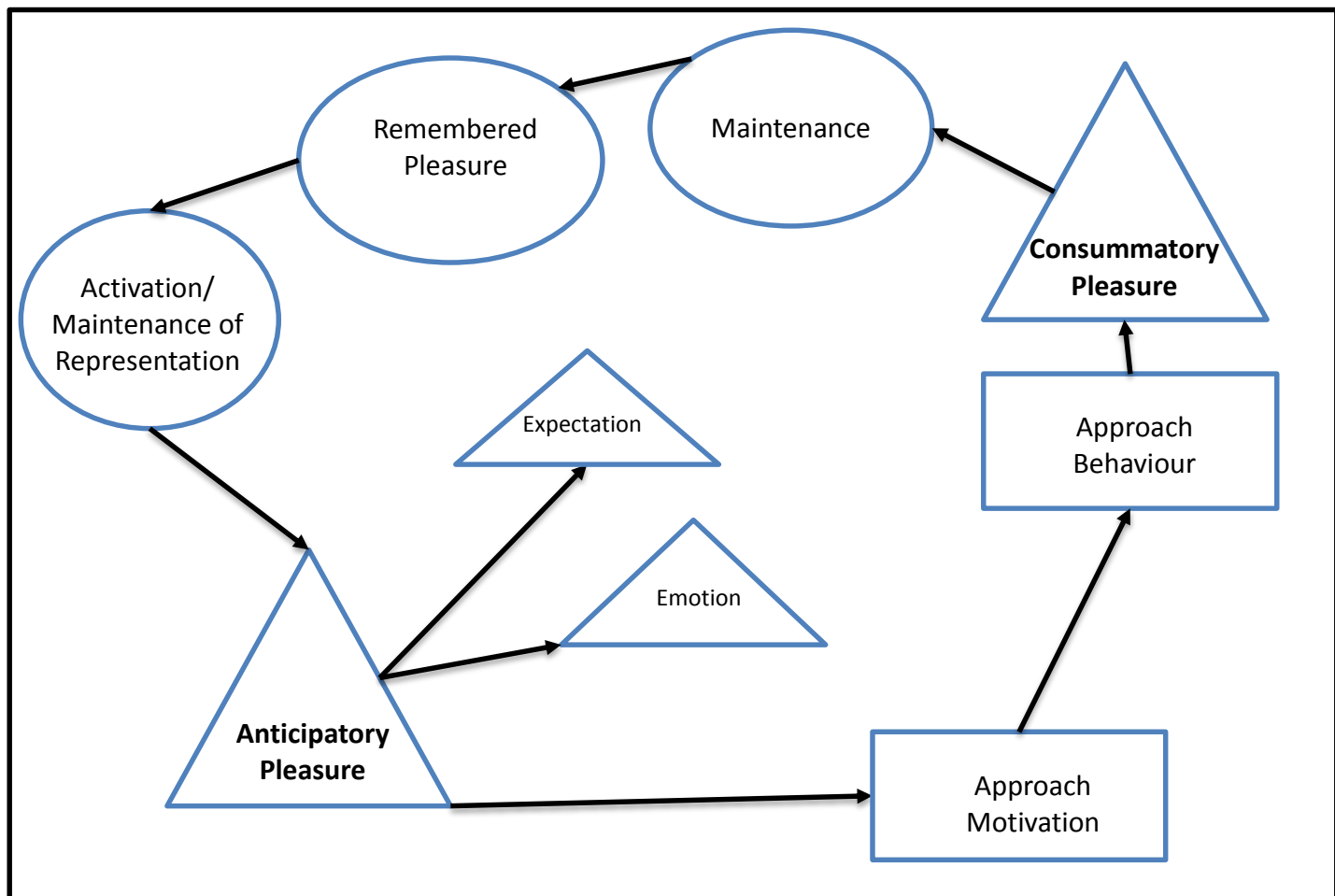
1.4 Models of Anhedonia and Amotivation

The combination of different methodologies (self-report, experimental tasks and ESM) has increasingly presented conflicting results about the nature of emotional experience in people with schizophrenia (Cohen et al., 2011). In questionnaires and interviews such as the PANSS, SANS and Chapman Scales, people with schizophrenia have consistently reported experiencing low levels of pleasure, termed anhedonia (Yan et al., 2012). However, in experimental paradigms which present individuals with different stimuli (e.g. tastes, pictures, videos, smells), people with schizophrenia report similar levels of pleasure to controls (Cohen & Minor, 2010). This has been replicated in everyday life using experience sampling which reports that people with schizophrenia experience similar levels of pleasure to controls during activities (Gard, Sanchez, Cooper, et al., 2014). These contrasting findings have been termed the “emotional paradox” of schizophrenia and have been the focus of model development in the last decade (Cohen et al., 2011; Kring & Caponigro, 2010; G. P. Strauss, 2013a).

1.4.1 Temporal Experience of Pleasure Model: Anticipatory Deficit Hypothesis

A highly influential model in the understanding of the “emotional paradox” has been the Temporal Experience of Pleasure (TEP) model (Kring & Barch, 2014; Kring & Caponigro, 2010). This proposes a link between pleasure, motivation and activity (see Figure 1). This model is the focus of this PhD due to the extensive research which has been conducted based on its proposals and the hypotheses it posits linking emotion with activity and functioning.

Figure 1: The Temporal Experience of Pleasure model. Triangles represent pleasure-related processes, circles represent long-term and working memory components and squares represent motivation and activity components



In this model, an important distinction is made between anticipatory pleasure (experienced prior to an event) and consummatory pleasure (experienced during the event). Anticipatory pleasure comprises both the cognitive expectation that a future event will

occur and the emotions evoked by that expectation (Kring & Barch, 2014). This is described as a “feeling state” in the original model but the term “emotion” is used in this version to differentiate it from mood, which is not incorporated into the TEP model but was assessed in this PhD. Kring and colleagues propose that the distinction between anticipatory and consummatory pleasure explains the conflicting results seen across different methods (Kring & Caponigro, 2010). Responding to a question in an interview or questionnaire such as “how much have you enjoyed your hobbies in the past week?” may engage anticipatory processes as the person reflects on their experiences. Anticipatory pleasure is also hypothesised to be a trait-like construct which is stable over time and produces consistently reduced ratings on questionnaire and interview items (Cohen et al., 2011). Questionnaires and interviews are therefore not valid measures of “in the moment” or consummatory pleasure and instead may reflect how much the individual anticipates pleasure. The experimental and experience sampling methodologies which assess pleasure experienced in direct response to a stimulus or event are therefore more valid measures of consummatory pleasure than questionnaires which rely on memory or hypothetical scenarios. The findings from these methods can be interpreted using this model to represent intact consummatory pleasure as measured experimentally or with experience sampling (Cohen et al., 2011). The high anhedonia scores on interviews and questionnaires may represent a specific anticipatory pleasure deficit in people with schizophrenia (Kring & Caponigro, 2010). According to the TEP model, reduced anticipatory pleasure leads to low motivation, reduced approach behaviours and therefore lower levels of activity. These components have been examined separately in the literature, and the results are synthesised in the systematic review in Chapter 2. No research has tested this hypothesised pathway from reduced anticipatory pleasure to reduced activity using the same methodology; this was a primary aim of this PhD.

The constructs of anticipatory and consummatory pleasure are grounded in the work by Berridge and Robinson (1998) and correspond to the reward functions of “wanting” (anticipatory pleasure) and “liking” (consummatory pleasure) in animal models and addiction research. The TEP model suggests that after an experience is initiated and enjoyed (consummatory pleasure), a long-term memory of the emotion associated with that experience and the ability to create and maintain a representation of it in working memory, contribute to anticipatory pleasure. Anticipatory pleasure is therefore grounded in past

experiences and dependent on the maintenance and availability of the memories of the pleasure related to those experiences. Anticipatory pleasure consists of *both* the cognitive expectation that the future event will occur and the feeling of pleasure experienced when anticipating the event. Once pleasure has been anticipated, motivation to complete that activity is generated as well as approach behaviours to seek it out in the future.

The authors who proposed this model have grounded their hypotheses in the neuroscience literature, and the TEP model was recently updated by integrating the anticipatory and consummatory constructs with this evidence (Kring & Barch, 2014). The functional Magnetic Resonance Imaging (fMRI) findings presented by these authors highlight the brain regions showing reduced activity compared to controls which are linked to negative symptoms: the dorsolateral prefrontal cortex (DLPFC), ventromedial prefrontal cortex (VMPFC) and orbitofrontal cortex (OFC). In these studies, the authors utilised different reward learning paradigms to investigate the processes which occur prior to and during the reward receipt (Dowd & Barch, 2012; G. P. Strauss et al., 2013). Several mechanisms involved in seeking and obtaining reward have been identified and investigated using this methodology including value computation, effort computation and executive functions (Barch, Treadway, & Schoen, 2014; Gold et al., 2008; Ohtani et al., 2014). These have been integrated into the TEP model as potential deficits which may contribute to reduced anticipatory pleasure and motivation (Kring & Barch, 2014). The systematic review conducted and described in Chapter 2 evaluates the potential of these processes as therapeutic targets.

This model, and specifically the anticipatory pleasure deficit it proposes, has had a long-reaching influence on research in the field. Since this deficit was suggested, researchers have examined factors which may contribute to the anticipation of pleasure. The experimental work in this area is summarised and critiqued in the systematic review in Chapter 2. Briefly, researchers have not identified an anticipatory pleasure deficit using experimental methods but have identified both intact and even heightened anticipatory pleasure in people with schizophrenia compared to controls (Choi, Lee, Ku, Yoon, & Kim, 2013; Trémeau et al., 2010; Trémeau, Antonius, Nolan, Butler, & Javitt, 2014).

A self-report questionnaire called the Temporal Experience of Pleasure Scale (TEPS) was developed by the TEP model authors to assess anticipatory and consummatory pleasure (Gard, Gard, Kring, & John, 2006). Findings using this measure have been mixed, with both reduced anticipatory pleasure and reduced consummatory pleasure reported in people with schizophrenia (Mote, Minzenberg, Carter, & Kring, 2014; G. P. Strauss, Wilbur, Warren, August, & Gold, 2011). This may be due to an inherent limitation in assessing consummatory pleasure using self-reported pleasure in hypothetical scenarios (e.g. “I enjoy taking a deep breath of fresh air when I walk outside”) which may engage anticipatory rather than consummatory processes. A recent study framed TEPS scores as “abstract” anticipatory and consummatory pleasure and reported anticipatory deficits in people across the course of schizophrenia with consummatory deficits present in the chronic group only (Li et al., 2015). The inconsistent findings in this field require clarification to determine whether the TEPS should be used in future research as an assessment of anticipatory and consummatory pleasure. This thesis aimed to contribute to the field by attempting to replicate the anticipatory pleasure deficit using the TEPS as well as examining its links with mood, symptoms and functioning.

Although this work is in its infancy, it is becoming increasingly evident that the method of measurement chosen for experiential deficits may influence both the results of the study and the conclusions that can be drawn from them (G. P. Strauss, 2013b).

1.4.2 Affective Forecasting Literature

The anticipation of pleasure in healthy individuals is also an important research area to consider when identifying the difficulties in people with schizophrenia. Researchers have referred to the anticipation of future emotion as “affective forecasting” in studies examining this process in healthy controls. This has largely been examined in the context of quality of life or psychological wellbeing as researchers were interested in the function of anticipation. Specifically, does our ability to anticipate pleasure give us pleasure in itself and/or does it drive us to do activities? It may also function as a warning or compensatory mechanism. If we do not anticipate much enjoyment from an activity, then we are aware that it may be tough and we will not be disappointed if it is unpleasant or difficult. It has been shown that people who take holidays from work are significantly happier overall prior to the holiday

compared to those not taking a vacation (Nawijn, Marchand, Veenhoven, & Vingerhoets, 2010). However, the effects of the vacation itself were short-lived and happiness returned to the same levels as people who had not been on holiday within two weeks of their return to work (Nawijn et al., 2010). Indeed, anticipation of a holiday has a significant impact on the wider concept of subjective well-being which is increased in individuals prior to their holiday compared to those who were not taking a holiday (Gilbert & Abdullah, 2002). These findings converge to suggest that the ability to anticipate pleasure is a powerful tool, more so than retrospective pleasure, and it operates to boost subjective well-being and positive emotion levels and therefore drives behaviour. Frederickson (2001) proposed the Broaden and Build Theory which states that positive emotion and anticipatory pleasure drive individuals to explore new avenues in their leisure activities and engage more in existing activities. If there are deficits in the anticipatory pleasure process in people with schizophrenia, this theory may contribute to our understanding of how these lead to a reduced interest in hobbies, activities and socialising and very little exploration of new activities in people with this diagnosis.

As well as the positive effects of anticipatory pleasure, research has demonstrated variability in affective forecasting. Studies have used autobiographical scenarios as stimuli and an observational design, examining events that occur in everyday life rather than manipulating them experimentally. The results of these studies showed both over- and under-anticipation of emotions depending on the event the participant was considering (Gilbert & Wilson, 2007). If participants were asked to forecast their emotions during a Monday at work they under-anticipated their pleasure, whereas if it was their birthday pleasure was over-anticipated (Robinson & Clore, 2002; Wilson & Gilbert, 2005). Gilbert and Wilson (2007) explained this inconsistency using heuristics and biases that may be employed by the individual when asked to forecast their future emotions. These authors proposed that a context bias is present and the individual's current mood and environment has an influence on their predictions. They also referred to the availability heuristic (Tversky & Kahneman, 1974). This states that when anticipating a future event, the individual incorporates their enjoyment from the most recent occurrence of that event as well as the best and worst occurrences in their predicted future enjoyment, as these are easily accessed due to their salience. The predictions made by the individual may therefore be biased

towards these more salient experiences. The role of context (mood and enjoyment) and availability biases in people with schizophrenia is unclear as anticipatory and consummatory pleasure, in relation to the same stimuli, have yet to be compared directly. The associations between context and anticipation in controls and people with schizophrenia were examined in this PhD using three methods: self-report, an experimental task and ESM.

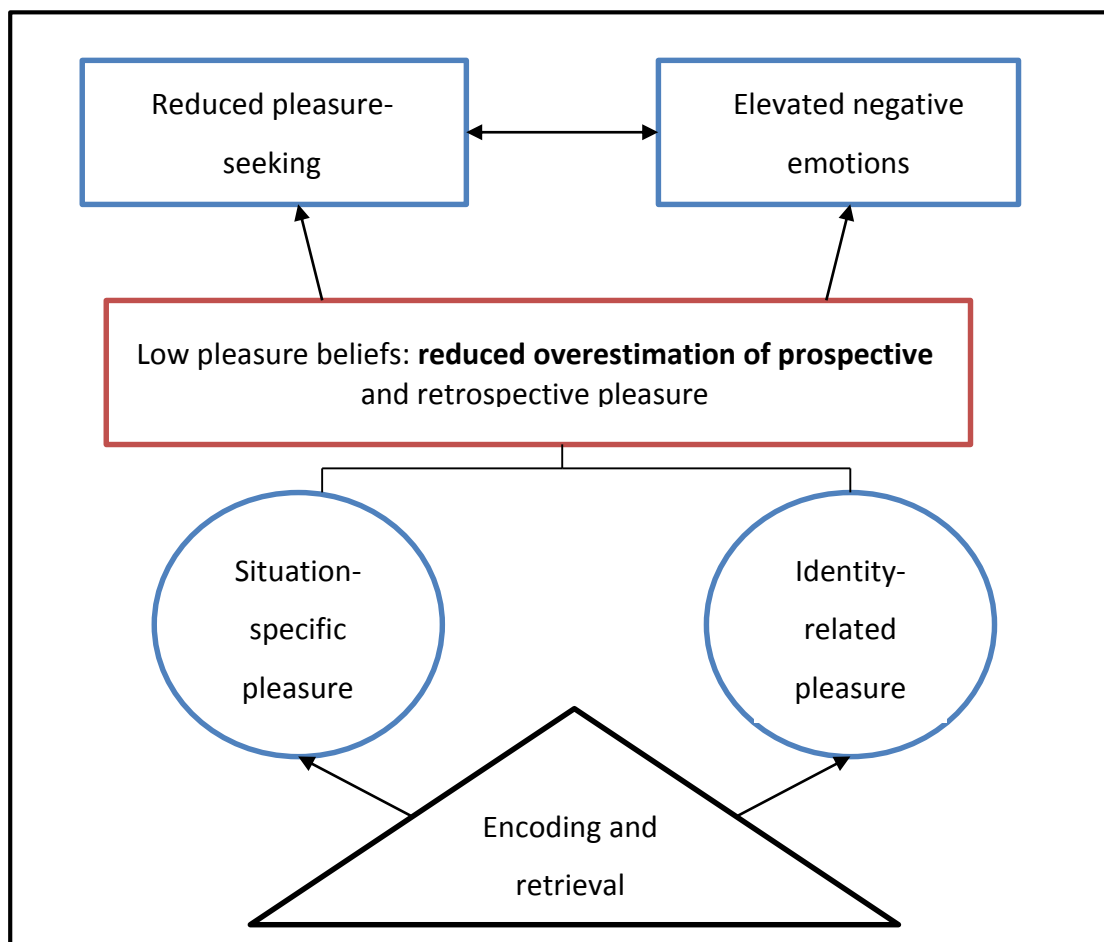
1.4.3 Three-Component Model of Anhedonia in Schizophrenia (G. P. Strauss & Gold, 2012)

Another model proposed in this field is that from Strauss and colleagues who were influenced by the idea of heuristics and biases in the control literature (see Figure 2). This model proposes that low pleasure beliefs play a role in reduced anticipatory pleasure in people with schizophrenia. Robinson and Clore (2002) describe in their Accessibility Model that when information from memories is difficult to access, individuals rely on their beliefs to answer questions or make predictions instead, as these are more easily available to them. G. P. Strauss and Gold (2012) extended this idea to suggest that beliefs may therefore play a role in the prediction of emotions. This is similar to the context bias described by Gilbert and Wilson (2007), with the exception that affective forecasting is hypothesised to be influenced by the individual's current beliefs and not their current mood. Strauss proposed that problems accessing memories may be more common in people with schizophrenia due to the well-documented cognitive problems in the disorder, particularly with emotional memory (Aleman, Hijman, de Haan, & Kahn, 1999; Herbener, 2008). Therefore, people with schizophrenia may rely on their beliefs more when predicting their future emotions. Strauss extended this idea to suggest that individuals with a diagnosis of schizophrenia may have low pleasure beliefs about situations or themselves (e.g. "I don't enjoy that activity" or "that activity is not enjoyable") either due to negative early experiences or a lack of opportunity to engage with enjoyable activities because of their mental health problems or other factors. This may result in forecasted emotions being influenced by these negative, low pleasure beliefs and the fact that people with schizophrenia report reduced anticipatory pleasure. This theory fits with the evidence presented concerning anticipatory pleasure in the control literature, specifically the overestimation rather than accurate forecasting of future pleasure in some situations. However, it has not been tested directly by measuring

low pleasure beliefs in people with schizophrenia, and it is unclear whether these are present.

Both the TEP model and three-component model appear to assume that an underestimation of pleasure would represent a deficit, but the control literature shows that this occurs in some situations in healthy individuals, and therefore it may be adaptive to a certain extent. This PhD aimed to contribute to the understanding of under- and overestimation of pleasure in controls, as the nature of a clinically-relevant outcome for anticipatory pleasure is currently unclear.

Figure 2: The three-component model: beliefs, mood and pleasure components (G. P. Strauss & Gold, 2012)

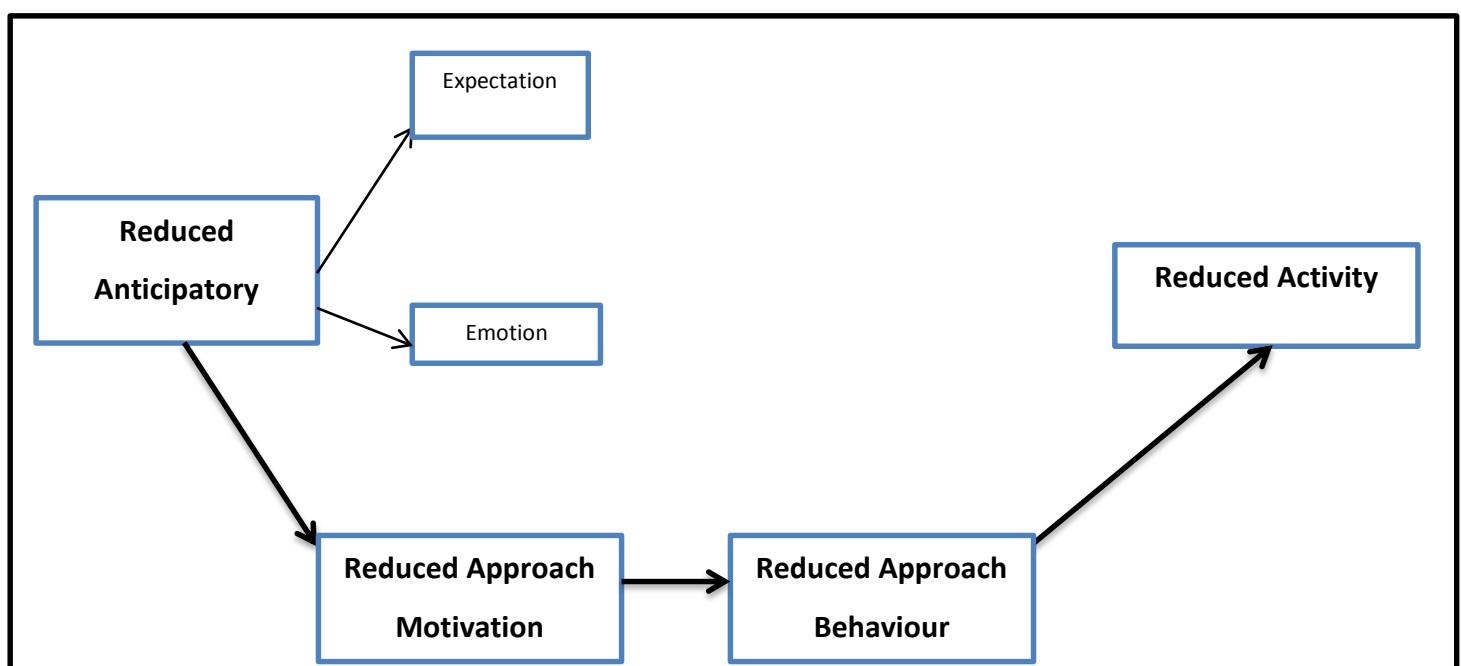


Both the three-component model and the TEP model assume that there is a specific anticipatory pleasure deficit in the context of intact consummatory pleasure in people with schizophrenia. The three-component model contributes an additional important perspective to the consideration of the deficits that may underlie reduced anticipatory pleasure. The role of beliefs should be considered in future studies and has been neglected in the field of

negative symptom research. More accurate measures of anticipatory pleasure are needed before the role of beliefs can be understood. The three-component model also proposes a role for mood which is not incorporated in the TEP model. This may be premature, as the influence of mood on pleasure in people with schizophrenia is yet to be established in the literature but again should be considered in future research. The TEP model proposes a clear pathway from reduced anticipatory pleasure to reduced motivation, leading to lower levels of activity and poor functioning (see Figure 3). The final stage of the three-component model is reduced anticipatory pleasure, and this model is therefore missing this crucial link to poor functional outcomes and quality of life.

The overall aim of this PhD was to contribute meaningful findings to the field of negative symptoms which would increase our understanding of the impact these difficulties have on functioning and suggest potential targets for intervention. Thus, the research conducted in this PhD empirically tested the pathway to poor functioning proposed in the TEP model (see Figure 3). The specific research questions and methodologies selected were developed on the basis of a systematic search of the empirical literature described in Chapter 2. This was conducted to ensure that the research that followed was novel and contributed meaningfully to the identification and evaluation of potential therapeutic targets in the TEP model.

Figure 3: Section of the adapted TEP model proposing the stages between anticipation and activity



Chapter 2: Empirical Support for Therapeutic Targets proposed by the Temporal Experience of Pleasure Model in Schizophrenia: A Systematic Review

2.1 Introduction

The Temporal Experience of Pleasure Model (Kring & Caponigro, 2010) (see Figure 1, Chapter 1) provides an explanation for the link between experiential negative symptoms, specifically anhedonia, and poor functioning (Rocca et al., 2014). This model firstly posits a clear hypothesis that a specific deficit in anticipatory pleasure produces low motivation and therefore reduced engagement in activity. Secondly, it proposes two key factors which may contribute to this specific anticipatory pleasure deficit: poor executive functions and difficulty forming and/or accessing emotional memories. The hypotheses presented in this model offer clear opportunities to identify potential therapeutic targets and therefore recommend future avenues of research into intervention development. For this reason it was selected as the theoretical basis for the work conducted in this PhD.

A current limitation of using this model as a basis for intervention development is the lack of conclusive evidence in the field. This is perhaps due to the wide range of methodologies used to examine the constructs proposed in the TEP model. As described in the previous chapter, this model has been updated to incorporate evidence from neuroscience research including processes such as effort and value computation (Kring & Barch, 2014). This has not only added to the list of constructs proposed as treatment targets in the TEP model but also to the range of methodologies used to examine the model e.g. reward learning paradigms and effort-based tasks (Gold et al., 2008; Treadway, Peterman, Zald, & Park, 2015).

Negative symptoms are a huge unmet clinical need in people with schizophrenia (Loas, Azi, et al., 2009). The overarching aim of this PhD was to produce a meaningful contribution to future intervention development through increased understanding of the deficits that may underlie the link between emotional difficulties and poor functioning

(Ergul & Ucok, 2015). The evidence gathered and summarised in the literature regarding the therapeutic targets proposed in the TEP model has only been in the form of narrative reviews (Kring & Barch, 2014; G. P. Strauss, 2013b; G. P. Strauss et al., 2013). These reviews may report the areas with the greatest need for future research with some bias. A comprehensive review of the literature which systematically assesses the support for each construct proposed in the TEP model was needed to inform the selection of the research questions and methodologies. The rationale for this PhD is then described on the basis of the gaps in the literature identified in this systematic review. It was decided to focus on evidence obtained experimentally, excluding reviews, as this has yet to be synthesised systematically and therefore has the greatest potential to produce novel research questions for this work.

The systematic review considered all experimental studies that included individuals with schizophrenia and measured both anhedonia (using a validated assessment tool) and one of the components of the TEP model: consummatory pleasure, memory, executive functions, reward representation, anticipatory pleasure or approach motivation and behaviours. The evaluation of these studies and the methodologies adopted, as well as the resulting consensus across the findings, were used to determine the research questions upon which this PhD should focus.

2.2 Method

This systematic review was conducted following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher, Liberati, Tetzlaff, Altman, & The Prisma Group, 2009). These have been designed to improve the transparency and quality of systematic reviews and have been used widely in mental health research (Gotink et al., 2015); see Appendix 1 for the completed PRISMA checklist.

2.2.1 Study eligibility

Studies were considered eligible if they:

1. Included a majority of individuals with a diagnosis of schizophrenia according to standardised diagnostic criteria from the Diagnostic and Statistical Manual of Mental Disorder (American Psychiatric Association, 2013), Research Diagnostic Criteria (Spitzer, Endicott, & Robins, 1978) or International Classification of Diseases (World Health Organisation, 1992);
2. Assessed anhedonia using validated instruments demonstrated by at least one published validation study in people with schizophrenia (self-report or clinical interview; see Table 3);
3. Were written in English;
4. Reported original empirical data; and
5. Did not *solely* include individuals with primary co-morbid disorders e.g. substance abuse.

2.2.2 Search Criteria

Both PubMed/MEDLINE and PsycINFO were searched up to April 2015 by CE using the following keywords: schizophrenia and anhedonia. Alternative search terms for anhedonia (e.g. pleasure, positive affect, and reward) were excluded after initial searches produced a very high proportion of irrelevant papers (i.e. 90%). Studies that only included participants with co-morbid substance or alcohol abuse diagnoses (i.e. investigated the impact of these co-morbid diagnoses on emotional experience) were excluded as anhedonia may be present due to this primary diagnosis and thus confound the investigation of the nature of anhedonia in people with schizophrenia. This focus on anhedonia in the context of negative symptoms of schizophrenia and not as the result of affective disorders is also the reason for narrowing the search to “schizophrenia” only. The studies that investigated the effectiveness of an intervention were therefore excluded from this review. The abstracts of all the retrieved papers were initially scanned to exclude irrelevant papers. Reference lists of recent reviews and meta-analyses (published from 2010 onwards) were also hand-searched

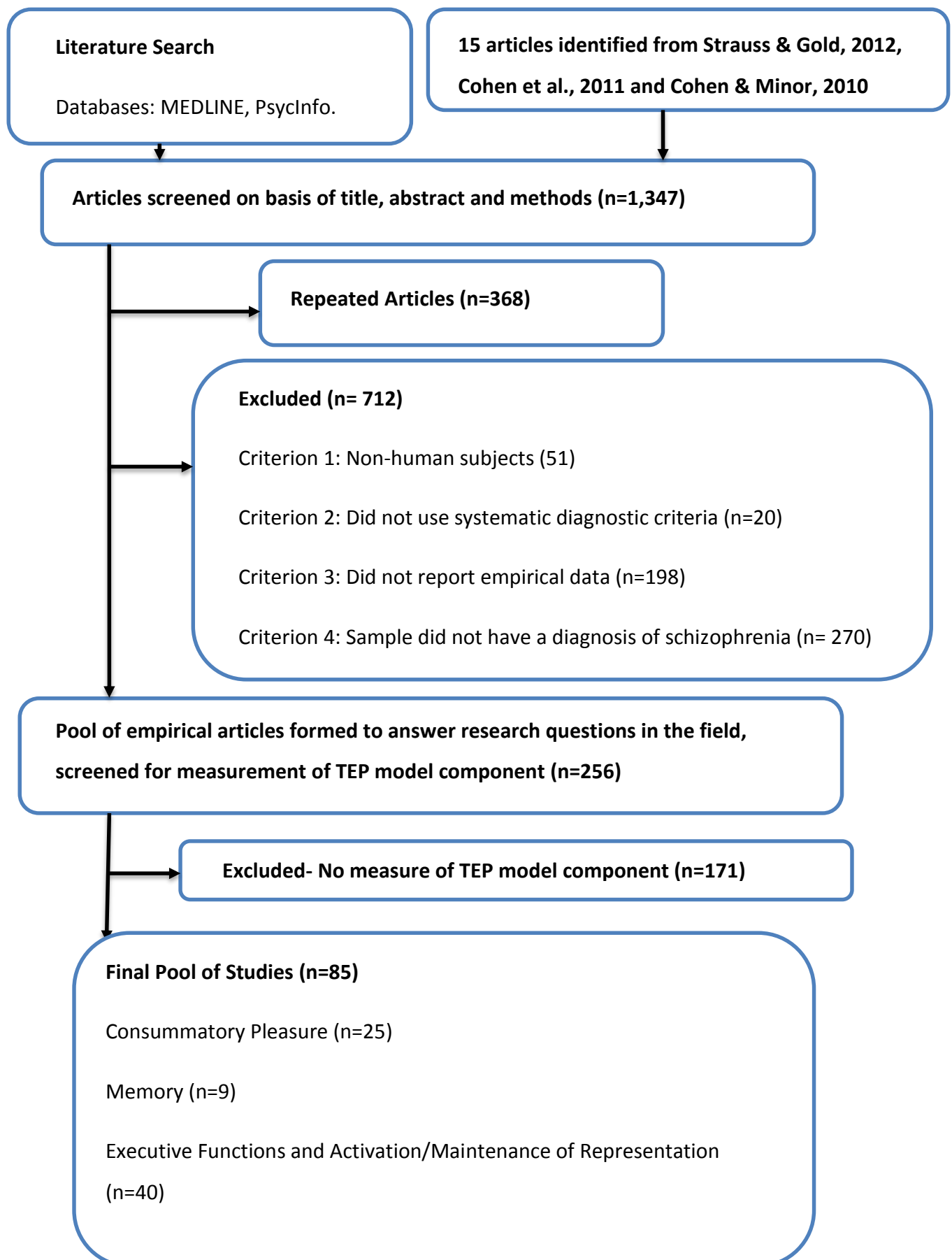
to identify any other possible relevant studies. The final list of included studies was reviewed by the PhD supervisors to ensure that none failed to meet the criteria.

The remaining empirical studies meeting the exclusion/inclusion criteria detailed in the method were reviewed and if a construct proposed in the TEP model (consummatory pleasure, memory, executive functions, working memory, anticipatory pleasure, approach motivation and behaviours) was measured then the paper was included. Each study was categorised by the TEP construct measured and the following data were reported in the full table of studies: sample size (or number of studies if meta-analysis), measure of anhedonia, methodology and main findings (see Appendix 2 for table of studies and categorisation). Quality rating protocols for the included studies were considered; however, the heterogeneity of methodologies and variables across studies (e.g. fMRI, structural MRI, Likert scales, experience sampling, smell identification test, event-related potentials) made these quality assessment protocols difficult to apply meaningfully. A full table of studies with detailed information about the protocol and findings of each was considered more relevant to the purpose of the review (Appendix 2).

2.3 Results

The initial search identified 1,332 potentially eligible studies across both databases (see Figure 4). The references of three reviews (Cohen and Minor, 2010; Cohen et al., 2011; Strauss and Gold, 2012) produced another 15 potentially eligible studies. Once duplicates had been removed a total of 968 abstracts were screened. Studies were excluded if the full text could not be retrieved (n=14) or if they: were not written in English (n= 85); did not use systematic diagnostic criteria (n=20); did not make a validated assessment of anhedonia (n=51); examined the effectiveness of an intervention (n=17); or studied primary co-morbid disorder (n=6). Articles with unclear relevance were discussed with the PhD supervisors. As a result of the selection criteria 256 papers detailing the results of 250 independent studies were finally considered (see Figure 4).

Figure 4: Consort diagram of studies included in the systematic review



A large proportion of the included studies (30%) reported either the prevalence or prognostic implications of anhedonia in people with schizophrenia. These results show that anhedonia is a stable symptom in individuals with schizophrenia (Buck and Lysaker, 2013; Dollfus and Petit, 1995; Horan and Blanchard, 2003) and high levels predict worse functional outcomes. These findings are well established and are not relevant for an evaluation of the TEP model so will not be discussed further.

2.3.1 Measures of Anhedonia

Table 3: Measures of anhedonia in schizophrenia

Name of Measure	Reference: Validation Study
Positive and Negative Syndrome Scale	Kay et al. (1987)
Scale for the Assessment of Negative Symptoms	Andreasen (1982)
Physical and Social Anhedonia Scales	Chapman, Chapman, and Raulin (1976)
Temporal Experience of Pleasure Scale	Gard et al. (2006)
Clinical Assessment Interview for Negative Symptoms	Horan et al. (2011)
Snaith Hamilton Pleasure Scale	Snaith et al. (1995)
Brief Negative Symptoms Scale	Kirkpatrick et al. (2011)

20 studies were retrieved in the search which assessed or validated a measurement of anhedonia (see Table 3). These measures are heterogeneous with some measuring more general symptoms alongside anhedonia and others specifically focusing on this symptom. Newer measures such as the CAINS and BNSS are being increasingly favoured by researchers. The Chapman scales were developed as an assessment of schizotypy and as such are grounded in assumptions that may not apply to people with a diagnosis of schizophrenia e.g. close friendships, family support and the opportunity to engage in activities. The Temporal Experience of Pleasure Scale (TEPS) is similar; it has been designed for use in both control and clinical populations and as a result assumes experiences occur in

both groups which may not be the case in the clinical group. In particular there may be fewer opportunities for eating out, rollercoasters, and holidays. It also assesses consummatory pleasure using hypothetical scenarios such as “I love it when people play with my hair” which may have limited validity as these experiences are not occurring “in the moment”. The Snaith Hamilton Pleasure Scale (SHAPS) is used rarely in the literature; it does focus on anhedonia more specifically but without replication it is difficult to assess its performance as compared to the other available measures. As the evidence for the expressive vs. experiential deficits grows in the field it is considered increasingly important to develop more specific measures of negative symptoms. This has been reflected in the newer self-report measures described (e.g. CAINS, TEPS) but these are still limited in their ability to capture “in the moment experience”. This focus on the development of specific measures was a rationale for the methods used in this PhD which will complement existing, newer, self-report measures.

2.3.2 Consummatory Pleasure

The finding that pleasure during activities or stimuli presentation is intact in people with schizophrenia is the most consistent in this field. A variety of stimuli have been used to measure anhedonia experimentally “in the moment” in the retrieved studies including: images, video clips, food, faces, words, sounds, smells and mood induction (Burbridge & Barch, 2007; Horan, Green, Kring, & Nuechterlein, 2006; G. P. Strauss & Herbener, 2011; Trémeau et al., 2009). In all studies in this category (n=25) the participants rated how pleasant they found the stimuli “in the moment”. Individuals with schizophrenia reported similar levels of pleasure to controls, which is confirmed across studies in two meta-analyses (Cohen & Minor, 2010; Yan et al., 2012). This finding was replicated for arousal ratings (Llerena, Strauss, & Cohen, 2012). These results suggest that enjoyment of experiences “in the moment” is intact. This is an important consideration in the development of a therapy as clinicians may be able to capitalise on current experience if they are targeting related processes such as anticipation. Although this is a well-established finding (Cohen & Minor, 2010; Llerena et al., 2012; Yan et al., 2012) it is important to note that the stimuli rated in an experimental context are carefully controlled and often selected from a small group of standardised stimuli e.g. International Affective Picture Scale (Lang, Bradley, & Cuthbert,

1999b). This method of measuring pleasure has limited real-world application but is valuable in studying short-term emotional responses. Technology has now been established to provide a focus on everyday ratings of enjoyment using experience sampling methodology (ESM) which overcomes this limitation. ESM studies assessed consummatory pleasure during everyday activities and replicated the finding of similar enjoyment in people with schizophrenia and controls (Gard et al., 2007; Sanchez, Lavaysse, Starr, & Gard, 2014).

The meta-analysis from Cohen and Minor (2010) reported that although levels of positive emotion were similar in people with schizophrenia and controls, the levels of negative emotion reported by people with schizophrenia were often higher. This high level of negative affect in the context of intact positive affect is termed “affective ambivalence” and was first described in schizophrenia by Bleuler (1950/1908). Studies using emotion induction techniques have also found that people with schizophrenia tend to report higher levels of negative and positive emotion concurrently (Trémeau et al., 2009). Intact or similar positive mood alongside higher negative mood compared to controls has also been shown in experience sampling studies which ask individuals to rate their mood at random times during their everyday lives (Oorschot et al., 2013; Sanchez et al., 2014). It is important that these findings have been replicated in everyday life using ESM and are therefore not an artefact of the limited authenticity of the image stimuli commonly used in experimental studies. The experience sampling study from Sanchez et al. (2014) demonstrated that the increased levels of negative emotion reported by people with schizophrenia were often present during activities they rated as pleasant and were therefore incongruent with their environment. This relationship between current mood and enjoyment requires replication and its impact on functioning should be examined.

2.3.3 Memory

The TEP model proposes that following an activity, the memory of the pleasure experienced and the details of the event contribute to anticipating future pleasure. It has therefore been hypothesised that those individuals with schizophrenia who have poorer memory will also report higher levels of anhedonia (G. P. Strauss & Gold, 2012).

Several studies examined this relationship using memory task performance and self-report measures of anhedonia (see Table 4). The results are inconclusive with some authors reporting impairment in visual and recognition memory associated with anhedonia (Brebion, David, Ohlsen, Jones, & Pilowsky, 2007; Brebion, Ohlsen, Bressan, & David, 2012; Kemali, Maj, Galderisi, Monteleone, & Mucci, 1987) but others reporting intact, if not superior, non-spatial, implicit and recognition memory associated with higher levels of anhedonia in individuals with schizophrenia (Brebion et al., 1999; P. O. Harvey, Bodnar, Sergerie, Armony, & Lepage, 2009; Stevens et al., 2002). The conclusions from these studies are limited as all those conducted by Brebion and colleagues include the same participants and the others include small samples which limits their generalisability ($n < 30$). Clearer hypotheses regarding which types of memory are linked to anhedonia (e.g. memory for positive experiences, autobiographical memory) and newer, more specific, measures of anhedonia (e.g. CAINS, BNSS) would enhance the validity and rigour of the studies conducted.

Table 4: Studies examining the relationship between emotional memory and anhedonia

Study	Task	Type of Memory Assessed	Anhedonia Measure	Participants	Results
P. O. Harvey et al. (2009)	Emotional face recognition memory task.	Emotional face recognition memory-recognition accuracy and response bias.	Chapman Scales	29 patients with schizophrenia and 27 matched healthy controls.	No significant correlations with social anhedonia scores and memory performance variables in the patient group ($p > .01$ required for significance).
Brebion, David, Ohlsen, et al. (2007)	Visual memory task.	Visual recognition memory. Spatial context memory.	SANS	41 patients with schizophrenia.	Anhedonia significantly correlated with a <i>reduction</i> in false recognition errors ($p < .005$). Spatial context errors not significantly associated with

					anhedonia.
Herbener, Rosen, Khine, and Sweeney (2007)	24hr image recognition task.	Long term recognition memory.	Chapman scales	33 patients with schizophrenia and 28 healthy controls.	No correlations with anhedonia questionnaires.
Brebion, David, Jones, Ohlsen, and Pilowsky (2007)	List discrimination task.	Temporal memory for verbal stimuli (words) - memory of order in which they were presented.	SANS	41 outpatients with schizophrenia and 43 healthy controls.	Affective flattening and anhedonia significantly inversely correlated with errors on this task ($p < .009$).
Horan et al. (2006)	Foods and film clips-pleasure ratings and delayed recall test.	4hr delayed discrimination task- recognition of stimuli and free recall of previous pleasure ratings.	Chapman Scale Physical Anhedonia	30 patients with schizophrenia and 31 healthy controls.	No significant differences between patients and controls in immediate ratings or the recall of these ratings. No results reported for anhedonia and accuracy of recognition.
Brebion, David, Jones, and Pilowsky (2005)	Word recognition task.	Immediate and delayed (5min) verbal recognition memory. Delayed (5mins) verbal free recall.	SANS	40 patients with schizophrenia.	Higher levels of anhedonia significantly inversely correlate with global false recognitions ($p < .05$), significant for delayed ($r = 0.33$, $p < .05$) and trend for immediate ($r = -0.3$, $p < .08$).
Stevens et al. (2002)	Serial reaction time task. Eye-blink conditioning. Explicit visuospatial	Implicit sequence learning. Spatial memory.	SHAPS	25 patients with schizophrenia treated with olanzapine, 25 patients with	SANS and SHAPS did not differ between patient groups. Anhedonia measures did not correlate

	memory.			schizophrenia taking classic neuroleptics, and 25 healthy controls.	with any of the learning performance scores ($r_s < .02$, $p_s > .05$).
Brebion et al. (1999)	Free recall task and two recognition tasks- intentional and incidental.	Free verbal recall. Intentional delayed recognition memory (1 min). Delayed incidental recognition memory (5 min).	SANS	33 patients with schizophrenia and 40 healthy controls.	Fewer intrusions in free recall significantly associated with higher levels of anhedonia ($r = -0.42$, $p < .025$). Lower decision bias (better performance) in recognition task significantly associated with anhedonia ($r = -.55$, $p < .001$).
Brebion, Bressan, Ohlsen, Pilowsky, and David (2010)	Reality monitoring task- typicality of responses- semantic memory.	Atypical category exemplars produced.	SANS Anhedonia- Asociality	41 people with schizophrenia and 43 controls.	Anhedonia significantly predicted the typicality of responses in the task.
Brebion et al. (2012)	Recall and recognition memory tasks of words and pictures.	Verbal, visual and source memory accuracy. Verbal, visual and source memory errors. Category production typicality score.	SANS Anhedonia- Asociality	41 people with schizophrenia and 43 controls.	Anhedonia significantly inversely correlated with verbal response bias ($r = -.36$), list discrimination errors ($r = -.46$), visual response bias ($r = -.46$), source memory response bias ($r = -.53$) and typicality production scores ($r = -.51$).

Studies assessing emotional memory, defined as memory for the emotions experienced during a previous event, report a consistent deficit in people with schizophrenia which is associated with self-reported anhedonia (Herbener, 2008). One study (Herbener et al., 2007) with a larger sample (n=33) than those studies with negative findings demonstrated that, unlike in controls, positive emotion did not enhance delayed recognition memory in people with schizophrenia but negative emotion did. This suggests that the emotional memory deficit may be specific to positive emotions - an important detail to note in the development of an intervention. Further support for the role of emotional memory in anhedonia comes from neuroimaging studies. These have focused on patterns of activity in the hippocampus and amygdala which are involved in the encoding-retrieval processes in emotional memory (Cohen et al., 2011). Activation in these regions is correlated with self-reported anhedonia during tasks involving emotional memory (Becerril & Barch, 2011; Dowd & Barch, 2010). Emotional memory is therefore a potential target for future interventions with a strong existing evidence base that supports its relevance to anhedonia.

2.3.4 Executive Functions and Representation Activation/Maintenance

The TEP model proposes that a representation of previous experiences and associated pleasure is activated and maintained to inform anticipatory pleasure. It has been suggested that a difficulty in building or activating these representations may underlie high levels of self-reported anhedonia (Burbridge & Barch, 2007; Cohen et al., 2011). Executive functions are hypothesised to be responsible for integrating all the relevant information “online” to build the representation and then maintain it in working memory in order for the individual to use it to guide decisions (Burbridge & Barch, 2007). These deficits would result in difficulties using prior experiences when anticipating and could therefore produce a failure to learn which activities had been enjoyable in the past. Individuals experiencing these problems are unlikely to repeat enjoyable activities and indeed goal-directed behaviours are reduced in people with schizophrenia (Gard, Sanchez, Starr, et al., 2014).

2.3.4.1 Relationship between Executive Functions and Anhedonia

In the studies considered in this review, no significant correlations were found between levels of anhedonia and performance on executive functioning tasks (see Table 5) including the Wisconsin Card Sorting task, the Verbal Fluency Test or the Stroop task e.g. (Larquet, Coricelli, Opolczynski, & Thibaut, 2010; Laurent et al., 2000). It is striking that all these studies used the Chapman psychosis proneness scales which are designed for use in non-clinical populations to assess schizotypy and may not therefore accurately capture the experience of individuals with schizophrenia i.e. asking them to rate scenarios that assume they have close friends or access to leisure activities. Replication with newer, more appropriate measures designed for clinical participants (e.g. CAINS) would more accurately reflect the relevance of this cognitive domain for anhedonia. The neuropsychological tasks used e.g. WCST, the Go/No Go task, may not be associated with self-reported anhedonia because they do not have an emotional component.

Table 5: Studies assessing the relationship between neurocognition and anhedonia

Study	Task	Measure of Anhedonia	Sample	Results
Larquet et al. (2010)	WAIS III. Stroop task. Trail Making Test. Verbal Fluency Test. Wisconsin Card Sorting task (WCST).	Chapman Scales	21 patients with schizophrenia spectrum disorders, 10 patients with orbitofrontal cortex lesion and 20 controls.	No significant correlations between WCST, Stroop, Trail Making or Verbal Fluency test and anhedonia in schizophrenia spectrum patients ($p > 1$).
G. P. Strauss, Frank, et al. (2011)	Go/No Go task.	SANS	51 patients with schizophrenia and 39 age-matched controls.	Go/No Go learning did not correlate with SANS scores. Reduced uncertainty driven exploration in the task was significantly correlated with anhedonia/asociality only- ($p < 0.05$).
Roux, Christophe, and Passerieux (2010)	Emotional Stroop task.	PANSS Chapman Scales	21 patients with schizophrenia spectrum disorders and 21 controls.	Higher reaction times on Stroop task associated at trend level with social anhedonia ($p = .052$) but not physical anhedonia ($p = 0.6$).
Demily et al. (2010)	Emotional Stroop task.	PANSS Chapman Scales	21 patients with schizophrenia spectrum disorders and 20 controls.	No significant correlations between Stroop task and social anhedonia ($p > 0.69$) or physical anhedonia ($p > 0.55$) in schizophrenia.
Laurent et al. (2000)	Degraded Stimulus-Continuous Performance Test (DS-CPT). Forced-choice span of apprehension test (SPAN). Digit symbol substitution test. Trail Making Test (A and B). Verbal fluency.	PANSS Chapman Scales	23 outpatients with schizophrenia spectrum disorders, at-risk group of 25 parents and 22 siblings, and 34 controls.	No significant correlations between any of these cognitive measures and the Chapman scales in the patient group ($p > .05$)

	Stroop task. WCST.			
Suslow, Junghanns, Weitzsch, and Arolt (1998)	Visual backward masking task. SPAN. Degraded Stimulus – CPT. WCST.	SANS	31 patients with predominantly negative symptoms.	Anhedonia-asociality significantly negatively correlated with preservative errors on WCST when medication is controlled for ($r = -0.48$, $p = <.001$). No correlations with the other tasks.
Blanchard, Bellack, and Mueser (1994)	WAIS-R.	Chapman Scales SANS	26 patients with schizophrenia, 9 patients with schizoaffective disorder and 9 patients with bipolar disorder.	No significant correlations between WAIS-R Information or Vocabulary sub-tests and either Physical or Social Anhedonia in the schizophrenia spectrum group ($r_s <.21$, $p_s >.05$).
Kemali et al. (1987)	Spatial and non-spatial conditional associative learning tasks.	SANS	21 male drug-free patients with schizophrenia spectrum disorders and 19 controls.	No correlation between spatial conditioning learning and SANS. Number of errors, reaction time and number of learned associations in the non-spatial learning task negatively correlated with SANS anhedonia subscales ($r_s = -0.5$, $p_s <.05$).
Barch, Yodkovik, Sypher-Locke, and Hanewinkel (2008)	WAIS III. AX-CPT. 2-back version of the n back task.	SANS Chapman scales	66 patients with schizophrenia and 44 controls.	No significant associations between any motivation measures and any of the measures of cognition except for 'motivation related to anxiety' which was negatively correlated with AX-CPT performance ($r = -.36$, $p <.05$). No results reported for anhedonia and cognition.
Franke, Maier, Hardt, Hain, and Cornblatt (1994)	CPT- Identical Pairs.	Chapman scales Physical anhedonia	35 patients with schizophrenia, 26 healthy siblings and 35 controls.	Performance on CPT did not correlate significantly with anhedonia scores in the schizophrenia spectrum group.
Waltz and Gold (2007)	Probabilistic reversal learning task.	SANS	34 patients with schizophrenia and 26 controls.	No significant association of reversal learning with anhedonia subscale of SANS ($P = 0.42$). Trend with affective blunting (0.06).
Becerril and Barch (2011)	2-back working memory task with emotional faces.	Chapman Scales SANS	38 patients with schizophrenia and 32 controls.	No significant associations between any measure of anhedonia and accuracy or reaction times on the 2-back working memory task.
Gold et al. (2008)	Speeded button pressing for	SANS	Summary results across 8 studies.	Correlations consistently observed below .3-.4 and non-significant with all these tasks.

	<p>pictures of different valence.</p> <p>Delayed discounting tasks.</p> <p>WCST.</p> <p>Probabilistic Reversal Learning tasks.</p> <p>Frank Probabilistic Selection Paradigm.</p>			
Berenbaum et al. (2008)	<p>Verbal and design fluency tasks.</p> <p>Reading span</p> <p>AX-CPT.</p> <p>Digit span forwards.</p> <p>Lateralised motor performance task.</p>	SANS	47 people with schizophrenia spectrum disorder.	<p>No association between anhedonia and fluency, working memory, digit span or episodic memory tasks.</p> <p>Anhedonia negatively correlated with lateralized task performance.</p>
Hammer, Katsanis, and Iacono (1995)	<p>WAIS-R.</p> <p>Verbal and Performance Scales.</p> <p>The Finger Tapping Test.</p> <p>Trail Making Test (A and B).</p> <p>WCST.</p> <p>Word Fluency.</p> <p>Rey Auditory Verbal Learning Test (RAVLT)- verbal memory.</p> <p>Benton Visual Retention Test Form (BVRT)- visual memory.</p>	SANS	65 people with schizophrenia.	<p>Anhedonia subscale of the SANS significantly associated with word fluency ($r=-0.27$), perseverative errors on the WCST (0.30) and reaction times on the Trail Making Test (A) (0.27).</p>
Burbridge	California	Chapman	49 people with	No association between Chapman

and Barch (2007)	Verbal Learning Test (CVLT). Digit Span Backward.	Scales	schizophrenia and 47 controls.	scale scores and cognitive measures.
Dichter, Bellion, Casp, and Belger (2010)	Forced-choice visual oddball task.	SANS Anhedonia-Asociality 2.17 (1.80)	16 individuals with schizophrenia spectrum disorder and 13 controls.	No association between behavioural scores on the task and any SANS subscales.
Szendi et al. (2006)	Digit Span Nonword Repetition Test. Corsi Blocks Visual Patterns Test. WCST. Towers of Hanoi. Letter and Category Fluency task.	SANS Anhedonia 1.6 (1.2)	13 males with schizophrenia and 13 male controls.	Anhedonia scores correlated with Corsi backwards task scores ($r=-.056$) and performance on The Tower of Hanoi task (-0.62).
Buck et al. (2014)	WCST.	PANSS	163 patients with schizophrenia: 52 of them with high depression/high anhedonia, 52 with low depression/low anhedonia, and 59 with low depression/high anhedonia.	No difference between groups with differing levels of anhedonia and scores on the WCST.
Matsuzawa, Shirayama, Niitsu, Hashimoto, and Iyo (2015)	Iowa Gambling task.	SANS total	61 people with schizophrenia and 50 age- and sex-matched controls.	Card choices (advantageous/disadvantageous) correlate with SANS anhedonia-asociality.

2.3.4.2 Relationship between Brain Activation in Executive Function Regions and Anhedonia

The neuroimaging literature shows different results to studies using neuropsychological tasks. Reduced activation has been reported in the dorsolateral prefrontal cortex, ventromedial prefrontal cortex, orbitofrontal cortex and the ventral anterior cingulate cortex during emotive or reward processing tasks that correlates with high levels of self-reported anhedonia (Dowd & Barch, 2012; I. H. Park et al., 2015; K. M. Park et al., 2009; Ursu et al., 2011; C. S. Wang et al., 2003). However, two studies with smaller sample sizes did not find these links (Gradin et al., 2011; Simon et al., 2010) and one reported a link with avolition but not anhedonia (Mucci et al., 2015). The majority of evidence from this group of studies is in contrast to that from laboratory-based studies. These findings suggest that reduced activity in areas of the brain implicated in executive function in schizophrenia is associated with high levels of anhedonia. Gambling and reward-based tasks were used in these studies which have increased emotional content as participants receive rewards for their behaviour. As a result, these tasks are more emotive than the neuropsychological tasks used in the behavioural studies described above (see Table 5) which do not utilise rewards. The fMRI studies could therefore be a more specific assessment of behaviours related to emotive rewards. The receipt of rewards alongside the executive function component of these tasks may result in the engagement of both reward and executive function processes and any links between them. This may explain why the results differ from those studies which used neuropsychological tasks as these do not have a reward component and perhaps will not engage reward processing or any links between these processes and executive functions.

Future research should be conducted with laboratory tasks containing an emotional component to gain a fuller understanding of any deficits in executive functions that may be linked to emotion processing. Neuropsychological tasks such as the WCST or Go/No Go are non-specific tests of cognition with each engaging multiple facets e.g. memory, inhibition of responses, top-down cognitive control and attention to provide correct responses. The reward processing tasks used in the fMRI studies are more targeted with each variable manipulated specifically between trials e.g. size of reward, probability, stimuli. This differing

specificity may also contribute to the disparate findings between the two methodologies and highlights the need for specific hypotheses and tasks to measure aspects of cognitive functioning related to emotion processing in future studies.

Although extensive research has been conducted into improving cognition in people with schizophrenia (Wykes et al., 2011), no studies have yet reported the effect that an improvement in executive functions has on the experience of pleasure.

2.3.4.1 Experimental Tasks of Representation Maintenance in Working Memory

Multiple studies demonstrate that people with schizophrenia have a deficit in active maintenance of non-emotional information in working memory, which was confirmed in a meta-analysis (N. F. Forbes, Carrick, McIntosh, & Lawrie, 2009). However, there is little behavioural evidence to support an association between working memory and self-reported anhedonia (see Table 5). Experimental tasks which assess how representations are maintained over time need to be utilised more often to directly test the hypothesis that there is a specific deficit in this process in people with schizophrenia. The tasks included in the table are non-specific and therefore only address this hypothesis indirectly. Gard et al. (2011) used a maintenance task which asked participants to rate the emotional intensity of an image and then repeated this rating after a 3 second delay. Individuals with schizophrenia were less consistent in their ratings across the delay than controls. This suggested a deficit in maintaining the representation of the pleasure experienced over a very short delay. The study conducted by Ursu et al. (2011) presented participants with affective pictures and measured activation during viewing and during a 12.5 second delay after viewing. The activity in the dorsolateral prefrontal cortex of people with schizophrenia was only reduced compared to controls during the delay, supporting the idea of a maintenance deficit and extending the behavioural finding of a 3 second maintenance deficit (Gard et al., 2011). Psychophysiological research also supports this finding; people with schizophrenia showed a similar attenuated eyeblink startle response magnitude to controls when viewing an affective image. The eyeblink startle response is attenuated as the positive image primes appetitive behaviours which are incompatible with the aversive emotion reaction of the eyeblink startle response (Skolnick & Davidson, 2002). Startle

probes were presented 2.5ms after the picture disappeared and whilst the attenuation of the startle response was maintained in the control group, it was no longer attenuated in the schizophrenia group (Kring, Germans Gard, & Gard, 2011). A recent study used the Sensory-Specific Satiety task to demonstrate that individuals with schizophrenia have difficulty accurately updating their representations of value compared to controls (Waltz et al., 2015). Participants in this study were given one drink (e.g. juice) until they were sated and then asked to rate the pleasantness of this drink compared to a different drink (e.g. milkshake). In this task people with schizophrenia did not show a satiety effect specific to the stimuli experienced and devalued sated and non-sated liquids similarly, unlike controls who devalued sated liquids more steeply. Future research should prioritise dynamic tasks such as these which examine how reward representation changes over time to understand better when difficulties with this process occur.

2.3.5 Anticipatory Pleasure

Anticipatory pleasure is experienced prior to an event occurring and is comprised of the cognitive expectation that the event will occur and the associated feeling of pleasure when looking forward to it. This component of the TEP model has been the major theoretical driving force behind research in the last two decades. Surprisingly, despite this focus in the theoretical literature, the majority of direct evidence for an anticipatory pleasure deficit comes from findings using the TEPS questionnaire and not experimental tasks. As discussed in Chapter 1 (Page 43), the use of this self-report measure to assess consummatory pleasure may be inherently limited as by asking people to rate hypothetical scenarios the ratings provided are not of their emotions “in the moment”. The majority of studies report significantly lower anticipatory pleasure subscale scores in people with schizophrenia compared to controls but similar consummatory pleasure (Chan et al., 2012; Gard et al., 2007; Mote et al., 2014). One study, however, reports the opposite finding (G. P. Strauss, Wilbur, et al., 2011) and the authors hypothesise that this may be due to the anticipatory ratings being influenced more by other factors (e.g. mood) and therefore less reliable across studies than the consummatory ratings. A recent study also found that people with schizophrenia who report high levels of negative symptoms have reduced

anticipatory pleasure on the TEPS compared to those individuals with low negative symptoms (Li et al., 2015).

One small study extends the use of self-report measures by using experience sampling methodology. This study reported reduced anticipatory pleasure in everyday life in the schizophrenia group compared to controls, alongside intact consummatory pleasure (Gard et al., 2007). However, the opposite finding of increased anticipatory pleasure in people with schizophrenia compared to controls was reported in a recent, larger ESM study (Gard, Sanchez, Cooper, et al., 2014). Furthermore, a second experience sampling study reported that individuals with schizophrenia over-anticipated the intensity of both negative and positive emotions when these predictions were compared with the emotions they experienced during everyday life (Brenner & Ben-Zeev, 2014). The findings from these studies and self-report measures provide limited support for anticipatory pleasure as a potential therapeutic target but self-report alone is a narrow evidence base on which to develop an intervention as it is susceptible to both memory deficits and desirability biases.

In contrast to the substantial evidence from studies using self-report, findings from experimental studies are mixed. Trémeau and colleagues conducted two studies using the same method. Participants were told details of the task they were about to complete and asked to rate how much they thought they would enjoy it (Trémeau et al., 2010; Trémeau et al., 2014). In the first study individuals with schizophrenia were similar to controls and in the second their anticipatory pleasure was increased compared to controls. However, the authors did report weaker predictive value of anticipatory pleasure for future consummatory pleasure in the schizophrenia group compared to the control group (Trémeau et al., 2010). Choi et al. (2013) also reported similar anticipatory pleasure between groups in a task where participants watched a preview of a film prior to the full length feature. There is therefore currently no evidence of an anticipatory pleasure deficit in people with schizophrenia when it is measured behaviourally. One study used psychophysiological measures instead of behavioural ratings and found reduced anticipatory event related potentials to affective and non-affective stimuli in people with schizophrenia compared to controls (Horan, Wynn, Kring, Simons, & Green, 2010; Wynn, Horan, Kring, Simons, & Green, 2010). This is, however, a very general measure of arousal and the interpretation of this as a reflection of anticipatory pleasure specifically is limited.

These experimental tasks are the beginning of an expanding field and may be limited by their use of previews and descriptions to generate anticipatory pleasure ratings. The process which occurs in everyday life to reach an anticipatory judgment uses information from previous similar experiences to generate emotional predictions regarding future events. Targeting this process may reveal specific deficits in schizophrenia as well as being more ecologically relevant.

It is hypothesised by Kring and Barch (2014) that the role of dopamine in signalling prediction errors may reflect the expectation component of the anticipatory pleasure construct in the TEP Model. Abnormal prediction error signalling in the striatum in people with schizophrenia has been seen in fMRI studies, with both reduced and increased activation in response to unexpected rewards reported (Gradin et al., 2011; Morris et al., 2012; G. K. Murray et al., 2008). One study found a specific reduction in positive prediction error (more reward than expected) signalling in the striatum whilst negative prediction error (less reward than expected) seemed to be intact (Waltz et al., 2009). In contrast, Dowd and Barch (2012) found intact prediction error responses in people with schizophrenia, although these were seen in cortical regions and not the striatum. In summary, it seems that prediction error signalling is abnormal in schizophrenia and may contribute to anticipatory pleasure deficits although the direction and magnitude of the differences in signalling compared to controls varies across studies.

These findings raise the important question of the role of dopamine in anticipatory pleasure, and therefore the potential effects of antipsychotic medication. In un-medicated people with schizophrenia reduced ventral striatum activity during anticipation of reward has been reported (Esslinger et al., 2012; Juckel, Schlagenhauf, Koslowski, Wustenberg, et al., 2006). One study which compared drug-free patients and those being treated with neuroleptics found that dopamine D2/D3 receptor availability was negatively correlated with affective flattening as measured by the SANS but not anhedonia/social withdrawal (Heinz et al., 1998). This finding was replicated (Schmidt et al., 2001) and the authors suggested that patients who experience dopaminergic dysfunction are able to experience pleasure but may struggle to respond to external stimuli which prompt them to seek it out, supporting the finding that antipsychotic medication may have a bigger impact on anticipatory than consummatory pleasure. It appears that reduced activation of the ventral

striatum in response to rewarding cues may occur in those people taking typical antipsychotics but not those taking atypical antipsychotics and this activation was correlated with negative symptom severity in the typical group only (Juckel, Schlagenhauf, Koslowski, Filonov, et al., 2006; Kirsch, Ronshausen, Mier, & Gallhofer, 2007; Schlagenhauf et al., 2008; Simon et al., 2010; Walter, Kammerer, Frasch, Spitzer, & Abler, 2009). An experience sampling study conducted with people taking tight- or loose-binding anti-psychotic medication found in the tight-binding group that greater D2 receptor occupancy was associated with greater negative affect and lower positive affect in daily life suggesting that medication may dampen positive emotional experience (Lataster et al., 2011). The role of medication in anticipatory processes is still unclear as the experimental studies returned in the search found no association between chlorpromazine equivalent dosage and anticipatory pleasure ratings (Choi et al., 2013; Trémeau et al., 2010; Trémeau et al., 2014). Future studies should record and analyse medication data to further elucidate this relationship.

2.3.6 Approach Motivation/Behaviour

The final stage in the cycle is the motivation and behaviours which increase the likelihood that an activity will be repeated. The model proposes that a reduction in anticipatory pleasure leads to reduced motivation and activity. Several studies have used self-report measures to assess motivation in people with schizophrenia. Two studies found no deficit in motivation in people with schizophrenia using the Motivational Trait Questionnaire (MTQ) (Barch et al., 2008) and Likert scales in relation to an experimental task (Trémeau et al., 2014). There were no differences between groups on any subscales on the MTQ (except lower anxiety-linked motivation in people with schizophrenia) or the ratings given during the Trémeau study. A recent study reported that motivational deficits measured using the Behavioural Activation and Behavioural Inhibition scales are stable across the illness with no differences between recent-onset and chronic individuals (Schlosser et al., 2014). Furthermore, it seems that any negative impact of anti-psychotics on motivation is minimal as a recent study showed no difference between scores in medication-free patients at baseline compared with the same people after 6 months of anti-psychotic medication; nor was there a correlation with dosage (Fervaha, Takeuchi, et al.,

2015). However, findings from self-report measures of motivation are limited as they may be particularly susceptible to social desirability biases and rely on the individual having insight into their symptoms; insight is shown to be reduced or absent in 30-50% of people with schizophrenia (Baier, 2010).

Motivation has also been divided into different components in this research area as the variety of factors that may drive behaviour is increasingly understood. One theoretical approach to this is Self-Determination Theory (Ryan & Deci, 2000) which states that humans are driven by innate psychological needs for autonomy, competence and relatedness as well as external motivation to receive reward and avoid punishment. An experience sampling study found that when asked to report their motivational drives people with schizophrenia reported fewer goals driven by a need for autonomy, competence or external reward compared to controls (Gard, Sanchez, Starr, et al., 2014). There were similar numbers of goals driven by relatedness (social motivation) and avoidance of punishment in people with schizophrenia and controls. People with schizophrenia reported higher levels of goals which were motivated by drives that were categorised as disconnected-disengaged i.e. choosing activities in order “to pass the time”, or because they had “nothing else to do”. This replicated an earlier study which showed intact global and social motivation in people with schizophrenia but reduced situational motivation, defined as that which is gained from the activity itself, compared to controls (Trémeau, Goldman, Antonius, & Javitt, 2013). These findings suggest the type of motivation being measured is important as there may be lower levels of certain drives (need for autonomy) but not others (avoidance of punishment) and these may be inaccurately confounded into a global motivation deficit. The importance of considering the nature of the motivational drive is confirmed in a study examining behavioural approach and avoidance profiles in different subtypes of people with schizophrenia (Reddy et al., 2014). This study reported that two different subtypes with high negative symptoms had differing motivational profiles – with one showing elevated social avoidance motivation whilst this was lacking entirely in the other group. So even within those individuals with high negative symptoms there may be different factors contributing to motivational deficits. Further research into what determines differences between individuals is needed.

Kring and Barch (2014) propose that effort computation - an estimate of the effort required to perform an activity - is also a component of motivation. This has been studied using experimental tasks which present participants with rewards that require different levels of effort to achieve (Green, Horan, Barch, & Gold, 2015). This has been an innovative field which has developed these tasks to overcome the weaknesses of self-report measures that may be particularly limited by desirability effects or poor insight when assessing motivation and goals. It has been shown that people with schizophrenia do not make optimal choices and are less likely to exert greater effort for larger or more certain rewards (Barch et al., 2014; Fervaha, Graff-Guerrero, et al., 2013; Gold et al., 2013). Two of these studies also report a correlation between low effort choices on the tasks and clinical assessments of amotivation and community functioning levels (Barch et al., 2014; Fervaha, Graff-Guerrero, et al., 2013). These findings were extended by a recent study which presented participants with choices that varied in effort, reward and probability using the Effort Expenditure for Reward Task (EEfRT) (Treadway, Buckholtz, Schwartzman, Lambert, & Zald, 2009). In this task "hard" effort trials involve pressing a button with the little finger on the non-dominant hand, "easy" effort trials ask the participant to use the index finger of their dominant hand to press the button. The number of button presses required can also be altered to vary the effort. People with schizophrenia exerted similar amounts of effort overall as controls but did not allocate their effort optimally to obtain rewards. Optimality of the performance was inversely correlated with negative symptoms (Treadway et al., 2015). One study reports no difference in effort discounting of rewards in people with schizophrenia compared to controls (Docx et al., 2015). Another study replicated this finding and showed that in the schizophrenia group effort discounting of rewards was specifically associated with apathy and not diminished expression (Hartmann et al., 2015). There was no variation in the probability of receiving the rewards in the effort-discounting task unlike in the EEfRT Task described previously, suggesting that variations in probability contribute to effort computation difficulties in people with schizophrenia. This may be relevant to everyday life where decisions are often made with a degree of uncertainty. An experience sampling study found that people with schizophrenia engage in fewer effortful activities and set fewer effortful goals than controls in everyday life (Gard, Sanchez, Cooper, et al., 2014). People with schizophrenia also rated the effort required for activities as significantly greater than independent raters coding the same activity suggesting that their effort computations

are also inaccurate in everyday life. A recent review of the experimental work in this area recommends effort-based decision making tasks as a potential negative symptom outcome measure for future studies (Green et al., 2015). Although the theoretical and experimental basis for using this task are strong the reliability data for effort-based tasks is not well established in the literature (Green et al., 2015).

The TEP model proposes that goal-directed behaviours follow motivation. For example, the more motivated an individual is to improve their IT skills the more likely they are to attend classes which will help them achieve this goal. An experience sampling study reported that individuals with schizophrenia completed fewer goal-directed activities than controls (Gard et al., 2007). Goal-directed behaviour has also been measured in the laboratory using an experimental task in which participants had to press a single button repeatedly to either avoid or view a picture they had previously rated (Heerey & Gold, 2007). The overall button press frequency of individuals with schizophrenia was similar to controls. However, individuals with schizophrenia did not press the button fewer times for images they had previously found unpleasant, or increase their frequency of presses for images they had previously found pleasant. This was interpreted as a failure to discriminate between pleasant and unpleasant images as consistently as the control group. These findings suggest a deficit in linking goals or preferences with actions.

2.4 Discussion

2.4.1 Potential Therapeutic Targets

The most consistent finding in the reviewed literature is that consummatory pleasure is intact in people with schizophrenia. Emotional memory emerges as an important deficit with a strong evidence base. There is preliminary support for deficits in executive functions and building/maintaining representations contributing to anhedonia using reward-based tasks. Additional findings from experimental tasks are in line with a deficit in maintaining representations over time. This is a promising area of research but needs further work as there are mixed findings in the studies which use neuropsychological tasks to investigate the relationship between executive functions and anhedonia.

There is preliminary self-report evidence for a specific anticipatory deficit in the context of intact consummatory pleasure in people with schizophrenia which requires replication using the TEPS as well as in an experimental context and in daily life. There is also some indication that individuals with schizophrenia may have difficulty translating motivation into actions towards desired goals.

2.4.2 Evaluation of the Systematic Review

This review aimed to identify evidence-based therapeutic targets amongst the constructs proposed in the TEP model and followed PRISMA recommendations. A publication bias in the literature is unlikely given that many studies included in the review reported null findings. The conclusions were limited by the measures of anhedonia used in the majority of studies (e.g. PANSS, BPRS, SANS), which are non-specific and do not reflect current thinking in this area. Future studies should prioritise more specific measures such as the CAINS and BNSS (Horan et al., 2011; Kirkpatrick et al., 2011). The impact of co-morbid diagnoses such as substance abuse on emotional experience was not assessed. However, studies which included people from across the course of the illness and with a range of severity of symptoms were included. Both inpatient and outpatient populations were also represented in the full table of studies. Studies that were conducted in many countries including China, Japan, Hong Kong, Germany, France, The Netherlands and Spain are reviewed; but some bias may have been introduced by excluding those not written in English, although this is considered unlikely.

2.5 Limitations of Current Evidence Base and Future Directions

In recent years the field has moved away from assuming that a unitary pleasure deficit is present in schizophrenia due to co-morbid depression (Romney & Candido, 2001). Instead multiple components involved in experiencing and anticipating pleasure have been considered separately (Kirkpatrick, 2014; Messinger et al., 2011). This evidence-based approach has revealed both intact consummatory pleasure and some areas where people with schizophrenia differ from the general population such as emotional memory (Herbener, 2008) and effort-computation (Docx et al., 2015). Experimental tasks have focused on consummatory pleasure, a now well-established intact component (Cohen &

Minor, 2010; Gard, Sanchez, Cooper, et al., 2014; Yan et al., 2012), but neglected other components of the TEP model. Anticipatory pleasure has rarely been studied using experimental tasks and the three studies which have included a measure of this are limited due to their lack of reliability data and the use of previews to generate anticipatory ratings. An important avenue of future research is an experimental paradigm which measures anticipatory pleasure based on previous experience and not a preview. This would advance the understanding of this construct in people with schizophrenia and the control population.

Studies assessing affective forecasting in the general population have measured anticipatory and consummatory pleasure to the *same stimulus or event* and therefore have been able to draw direct comparisons and conclude whether individuals over- or underestimate and to what extent (Gilbert & Wilson, 2007; Wilson & Gilbert, 2005). This approach needs to be applied to studying anticipatory and consummatory pleasure in clinical populations, enabling a comparison to be made with healthy controls.

A thorough examination of the role of antipsychotic medication in emotional difficulties in schizophrenia is also needed. There is some indication that medication may be associated with reduced pleasure in imaging studies (Juckel, Schlagenhauf, Koslowski, Filonov, et al., 2006) but it does not appear to be associated with anticipatory pleasure in experimental studies (Trémeau et al., 2014). Clarification of these findings is important as the majority of individuals with schizophrenia are prescribed antipsychotic medication. There is some evidence that antipsychotic medication can generate improvement in negative symptoms (Fusar-Poli et al., 2014) but the findings are inconsistent (Lieberman et al., 2005) and modest at best. Further research into the impact of different types of antipsychotics is also needed as there is preliminary evidence to suggest that typical antipsychotics have a larger negative impact on pleasure than atypical antipsychotics (Juckel, Schlagenhauf, Koslowski, Filonov, et al., 2006; Schlagenhauf et al., 2008).

There has been extensive use of self-report measures in this field of enquiry which rely heavily on retrospective emotional memory. This is often impaired in individuals with schizophrenia and future research should focus on using methodologies which minimise this (Herbener, 2008). Experience sampling methodology has shown promise in this field and allows a direct measurement of activity levels and pleasure experienced during everyday life

(Kimhy et al., 2012; Sanchez et al., 2014). A study which assesses all the components of the TEP model suggested as contributing to functioning or activity levels i.e. anticipatory pleasure, motivation and activity levels is clearly missing from the current literature. Studies have each measured only one component and this has forced comparisons across very different methodologies when trying to understand the evidence for the model as a whole. Future studies should prioritise the examination of the relationships between anticipatory pleasure, consummatory pleasure, motivation and activity levels using a methodology that would allow a direct comparison between these components.

The work from this chapter has been accepted for publication in Schizophrenia Research and is currently in press. *Investigating the Empirical Support for Therapeutic Targets proposed by the Temporal Experience of Pleasure Model in Schizophrenia: A Systematic Review.* Edwards, C.J., Cella, M., Tarrier, N., Wykes, T. (2015).

2.6 Thesis Rationale

Negative symptoms are strongly linked with poor functional outcomes in people with schizophrenia yet interventions which are currently offered to individuals experiencing these difficulties have modest effectiveness at best (Elis et al., 2013; Fusar-Poli et al., 2014; Velthorst et al., 2014). The Temporal Experience of Pleasure model offers a theoretical basis for the progression of the field by suggesting that there is an anticipatory pleasure deficit in people with schizophrenia (Kring & Caponigro, 2010) which drives reduced motivation and activity levels. This systematic review of the literature revealed very heterogeneous findings in the studies investigating the components of this model. Consistent deficits were identified in emotional memory (Herbener, 2008), executive functions (Fioravanti, Bianchi, & Cinti, 2012) and motivation (Gard, Sanchez, Starr, et al., 2014) in people with schizophrenia.

The inconsistency in the field emerged when researchers attempted to test the TEP model by linking these processes to anhedonia or negative symptoms, usually measured with a self-report questionnaire. The possible conclusions which could be drawn from these mixed findings were either (i) the TEP model is flawed and these components are not linked to anhedonia, or (ii) the self-report measures commonly used do not assess anticipatory

pleasure. The limitations of self-report questionnaires and interviews such as the PANSS, SANS, Chapman Scales and TEPS were discussed at length in both the current and previous chapter. It was therefore premature to assume that the disparate findings in the field suggested that the hypotheses proposed by the TEP model should be rejected. Further studies assessing emotional memory and executive functions would only add to the inconsistency in this field using these measures. Therefore, before further research into emotional memory and executive functions in the TEP model is conducted it was considered imperative to develop new specific and reliable measures of anticipatory pleasure; this was the first aim of this PhD. A more accurate assessment of anticipatory pleasure would make it possible to test both the presence and relative strengths of the links proposed by the TEP model.

This decision to focus on anticipatory pleasure was made for two reasons. Firstly a reliable assessment of this component enabled a study to be conducted identifying factors which potentially contribute to reduced anticipatory pleasure such as negative beliefs, emotional memory, executive functions, effort computation and value computation. It was also considered important to develop a reliable assessment of anticipatory pleasure before further neuroimaging studies are conducted. Previous research has conducted analyses which explore the correlation between activity in brain areas and self-report measures of negative symptoms which as discussed previously are very non-specific and the findings have been mixed (Gradin et al., 2011; Simon et al., 2010). Secondly, a more accurate measure enabled the links between anticipatory pleasure, motivation and functioning, which are proposed in the TEP model, to be assessed. This assessment could then be used as an outcome measure for interventions targeting experiential negative symptoms. This hypothesised link to reduced functioning is absent from the three-component model, which also hypothesises an anticipatory pleasure deficit, and therefore there was a clear rationale to ground this work in the TEP model. This research was well placed in the wider context of schizophrenia research which has moved away from symptom reduction as the sole desired outcome of interventions and currently prioritises improvement in functioning. Thirdly, an assessment of anticipatory and consummatory pleasure using the same methodology enabled the discrepancy between these two constructs to be calculated, replicating the methodology seen in the control literature. This facilitated the identification and exploration

of any over-or under-anticipation that occurs in the schizophrenia group and allowed a direct comparison with the adaptive processes seen in controls.

Three methods have been used previously to assess anticipatory pleasure and all of these were utilised in this study: the TEPS, an experimental paradigm, and experience sampling methodology. As discussed in Chapter 1 (Page 38) these methods complement the findings from traditional symptom measures, which have contributed the majority of findings in the current literature. They allowed more specific constructs to be targeted and findings in everyday life to be replicated. The development of the methods used in this PhD was grounded in the important distinctions emerging in the literature: anticipatory vs. consummatory (Kring & Caponigro, 2010), internal experience vs. activity (Malaspina et al., 2014) and social vs. non-social (Cohen et al., 2011) (see Chapter 1). By ensuring that these components are measured separately the risk of confounding was removed and any differing relationships with functioning or other components of the TEP model could be identified.

The other focus of this body of work was to examine multiple constructs in the TEP model using the same method. The range of methodologies used to assess different constructs is a current limitation when drawing conclusions across the field. For example, consummatory pleasure is most often measured using pleasure ratings of images in an experimental context whereas anticipatory pleasure is commonly assessed using fMRI (Choi et al., 2013; Gold et al., 2012). The initial step of this body of work was to examine both anticipatory and consummatory pleasure using an established measure - the TEPS. Findings from previous work were extended by placing this measure in the wider context of current mood, symptoms and activity levels. The next step involved a novel experimental paradigm. By measuring both anticipatory and consummatory pleasure in the same experimental paradigm - the COP task - conclusions could be drawn regarding the differences between these two experiences of pleasure. Both constructs were examined in everyday life alongside motivation and activity levels in the final phase of the thesis. Anticipatory and consummatory constructs have been measured in experience sampling studies previously which show this to be feasible (Gard et al., 2007; Gard, Sanchez, Cooper, et al., 2014). This phase, as well as the COP task, allowed conclusions to be drawn regarding the pathway from anticipatory pleasure to activity proposed in the TEP model and removed the potential

confounding of different methodologies assessing different constructs. The findings from the systematic review indicated that the translation of motivation and anticipatory pleasure into activity may be an area of difficulty for people with schizophrenia. A further aim of this work was to assess support for this potential therapeutic target by examining the nature of this pathway using three different methodologies that each assesses both anticipatory and consummatory pleasure.

2.7 Research Questions

The overarching aim was to assess the TEP model as an explanation for why individuals with schizophrenia engage in fewer activities despite reporting similar pleasure to controls. The project therefore focused on the anticipatory pleasure deficit hypothesis. To identify more accurately where difficulties occur in people with schizophrenia, a healthy control group was included as a comparison.

The initial study focused on the self-report TEPS measure as an assessment of anticipatory and consummatory pleasure and the first question was whether ratings from this questionnaire demonstrate an anticipatory pleasure deficit in people with schizophrenia. Secondly, most of the literature in this area proposed or demonstrated links between anticipatory pleasure and mood, symptoms or functioning. The second research question was whether these links could be replicated using the TEPS self-report measure.

A new paradigm, the COP task, was developed to measure consummatory and anticipatory pleasure experimentally and the important research question was whether these ratings showed good test-retest reliability in both the control group and people with schizophrenia. The reliability of the COP task was assessed and it was then used to examine whether anticipatory and consummatory pleasure are similar in people with schizophrenia and controls. A second research question was whether this pattern was different for social vs. non-social images since a specific social deficit in people with schizophrenia had been hypothesised in the literature. As described above one key reason for developing this task was to measure anticipatory and consummatory pleasure using the same stimuli. This enabled a third research question to be addressed; is the discrepancy between the anticipatory and consummatory ratings of the same stimuli larger in the schizophrenia

group and if so, in what direction? In other words, do people with schizophrenia over- or under-estimate their future pleasure and to a greater extent than people in the general population? The COP task was also used to test the hypothesis from the TEP model that self-report negative symptom measures assess anticipatory pleasure, not consummatory. The important research question of whether antipsychotic medication contributes to a reduction in the experience of either consummatory or anticipatory pleasure was addressed using COP task ratings.

The experience sampling study was conducted over 6 days and participants completed a feedback questionnaire at the end. This enabled research questions regarding the validity of the methodology to be addressed as this questionnaire assessed whether an individual's typical routine was altered by taking part. If participants were changing their routine substantially this lowers the typicality of the week and the validity of the findings. Compliance rates during the study were also assessed to identify whether any fatigue effects were present and whether medication and/or symptoms played a role in reducing the number of questionnaires an individual with schizophrenia could complete. The final research question investigated whether the experience was acceptable for participants overall and specifically regarding training and burden.

The experience sampling study assessed consummatory pleasure, anticipatory pleasure, motivation, expectation and activity levels for social and non-social activities in everyday life and specifically whether these differ in people with schizophrenia compared to a healthy control group. The influence of current context on anticipation has been highlighted in studies conducted with people without mental health problems, in particular the role of mood and enjoyment of recent activities (Gilbert & Wilson, 2007). The association between these contextual factors and anticipatory ratings was assessed using experience sample methodology. The temporal nature of the data enabled research questions concerning the factors that drive activity or behaviours to be investigated by entering these constructs into a model as potential predictors of future activity. This was investigated for both non-social and social activities to assess whether social situations are particularly problematic for people with schizophrenia as had been hypothesised in the literature.

In the final study the degree to which the three forms of measurement; self-report, experimental and experience sampling measure the same constructs was assessed. Experience sampling methodology data was used as a “gold-standard” to assess the external validity of the experimental task and TEPS self-report measure. The inclusion of these three approaches with the same participants enabled a thorough assessment of the constructs of the TEP model to be made. The overall aim of the analyses in this final chapter was to inform researchers of the strengths and weaknesses of each method and recommend which should be prioritised in future research.

Chapter 3: Methodology

The data were collected in this thesis using three distinct methodologies the self-report TEPS measure, a new experimental paradigm (Components of Pleasure (COP) task) and experience sampling methodology (ESM). These three approaches have individual strengths which overcome limitations of the previous literature as described in Chapter 1 (Page 38). The ESM and the COP task avoid reliance on accurate retrospective recall seen in traditional self-report measures, which is often limited in people with schizophrenia (Aleman et al., 1999). They also allowed increased specificity compared to traditional self-report questionnaires and interviews, enabling important distinctions in negative symptoms to be examined (Malaspina et al., 2014; Messinger et al., 2011).

They are also three very different methodologies, with the TEPS and COP task taking place in a laboratory environment and the other in the individual's everyday life. This complementary combination strengthened the findings of this thesis. Firstly, the TEPS and experimental paradigm provided control over the stimuli presented to the participant. Although slightly artificial, this means conclusions can be reached which are based on the assumption that each individual experienced the same stimuli and environment during the task. This removed possible confounding factors, such as social content in the stimuli or the order in which they are presented to the participant. One limitation of such a paradigm is that in everyday life the environments experienced by each person vary and the laboratory may therefore be an artificial setting from which to generalise findings to the wider population. The inclusion of experience sampling methodology accounted for this to some extent as it provided an opportunity to confirm any findings in everyday life. In this methodology the researcher relinquishes the ability to standardise the individual's environment and the stimuli they interact with. This method is therefore more observational and important to place in the context of findings from experimental paradigms and self-report measures as discussed in Chapter 1 (Page 37). The three methods complemented each other and together formed a comprehensive assessment of the anticipatory pleasure deficit hypothesis. All three methodologies are described in detail here and this chapter is referred to in each relevant chapter that follows.

As well as detailed explanations of the methodologies, other assessments employed are described. Inclusion/exclusion criteria for the sample recruited for the study are presented as well as the power calculations used to determine the number of participants. Finally, an overview of the analyses conducted in each study is described at the end of this chapter.

All research procedures employed in this thesis were reviewed and received favourable ethical approval from the NHS Harrow-London National Research Ethics Service Committee on 08/11/12 (ref: 12/LO/1524) and R&D approval from the South London and Maudsley NHS Trust on 22/11/12.

3.1 The Components of Pleasure (COP) Task

3.1.1 Task Rationale

A wide range of methodologies has been used to assess anticipatory and consummatory pleasure in the literature. These methodologies are summarised in Table 6 below.

Table 6: Methodologies utilised in the assessment of anticipatory and consummatory pleasure

	Method	References
Consummatory Pleasure	Smells	Crespo-Facorro et al. (2001); Plailly, d'Amato, Saoud, and Royet (2006)
	Mood Induction	F. Schneider, Gur, Gur, and Shtasel (1995)
	Images	Cohen and Minor (2010); Herbener, Song, Khine, and Sweeney (2008); Yan et al. (2012)

	Video Clips	Choi et al. (2013)
	Experience Sampling	Gard et al. (2007); Gard, Sanchez, Cooper, et al. (2014); McCormick et al. (2012)
	Self-Report (TEPS)	Chan et al. (2012); Mote et al. (2014)
	Neuroimaging	Dowd and Barch (2012)
Anticipatory Pleasure	Film Trailers	Choi et al. (2013)
	Written Descriptions of Upcoming Tasks	Trémeau et al. (2010); Trémeau et al. (2014)
	Experience Sampling	Gard et al. (2007); Gard, Sanchez, Cooper, et al. (2014)
	Self-Report (TEPS)	Mote et al. (2014); G. P. Strauss, Wilbur, et al. (2011)
	Neuroimaging	Esslinger et al. (2012)

Although there is some overlap between the methodologies used to measure each construct only the experience sampling studies have measured both anticipatory and consummatory pleasure using the same stimuli: everyday life events. As discussed, these events can be hugely variable and idiosyncratic so conclusions from these studies would be strengthened by replication in a more controlled environment. No experimental task has measured both anticipatory and consummatory pleasure using the same stimuli. The COP

task did this to enable direct comparisons to be made between consummatory and anticipatory ratings. This necessitated the inclusion of *a learning component* in order to elicit anticipatory ratings from participants without the image itself being presented. The task cannot present the stimulus to the participant again when eliciting anticipatory pleasure as ratings given during stimulus presentation would be consummatory (“in the moment”) and not anticipatory. Learning an association between each stimulus and a cue allowed participants to provide their anticipatory ratings in response to the cue and not the stimulus. This is similar to the learning process in the monetary incentive delay task which is described in Chapter 1 and has been used extensively with people with schizophrenia (Page 35) (Knutson et al., 2001). It also mimicked the process of anticipating pleasure from events in everyday life which is often based on previous experiences and associated stimuli. As difficulties in associative learning have been reported in people with schizophrenia (Heinrichs & Zakzanis, 1998) a threshold was included in the learning phase which was determined through piloting the task (see below). Learning was also controlled for in the anticipatory phase. After an individual provided their anticipatory pleasure rating in response to the cue they were asked to indicate which stimulus was associated with that cue. This allowed any incorrect trials to be excluded and in this way any difficulties with the learning phase were controlled for.

According to two recent meta-analyses (Cohen & Minor, 2010; Yan et al., 2012) the presentation of images has been most consistently used to measure consummatory or “in the moment” pleasure in people with schizophrenia. The majority of the studies included in these meta-analyses used images taken from the International Affective Picture Scale (IAPS), a standardised collection of images categorised as pleasant, neutral or unpleasant as rated by more than one hundred participants (Lang, Bradley, & Cuthbert, 1999a). The IAPS stimuli were also used in the COP task. Pleasant images were used since the focus of the research was on the experience of pleasure and not negative emotional reactions. Unpleasant images were not included in the task; previous research suggests reactions to unpleasant images in people with schizophrenia are largely similar to controls “in the moment” (Cohen & Minor, 2010). Images are potentially limited in their ability to evoke emotions but the IAPS list allows the selection of standardised images consistently rated as positive or neutral. The TEP model has been grounded in evidence from the use of emotional images and by using

these stimuli findings from this body of work could be easily placed in the context of the wider literature (Cohen et al., 2011; Kring & Caponigro, 2010; G. P. Strauss & Gold, 2012). The use of images also afforded substantial control over the content of stimuli and the opportunity to use a large number of different stimuli, which is an advantage over mood induction and video clip stimuli. The previous experimental paradigms which assessed anticipatory pleasure only used a single stimulus (Choi et al., 2013; Trémeau et al., 2014) which reduced the robustness of the findings. The use of multiple images for anticipatory ratings conveyed increased reliability to the COP task compared to previous studies. The use of images to measure both consummatory and anticipatory pleasure allowed any discrepancy between these two constructs to be calculated. The COP task was therefore the first experimental paradigm to report any discrepancy between anticipation and actual experience as well as whether this is due to over- or under-anticipation. This replicated the method used in everyday life in the affective forecasting literature to examine anticipatory processes in controls. The COP task was used to compare discrepancies in people with schizophrenia directly with the adaptive over- and under-anticipation reported in a comparison group from the general population.

The task stimuli included an equal number of social and non-social stimuli pictures. The inclusion of both social and non-social images was important as it allowed the potential social-specific pleasure deficit proposed by some authors (Cohen et al., 2011) to be examined. To ensure the validity of the pleasant images chosen for use in the task a neutral set of pictures were included as a comparison condition.

A large number of stimuli could be presented to the participant in the consummatory rating phase. However, due to the necessity of including a learning component these could not all be included in the anticipatory phase as cognitive load on participants should be minimised to maximise learning, and then controlled for in subsequent analyses (Frydecka et al., 2014). The selection of stimuli for use in the learning and anticipatory phases is an area where bias could be introduced in the task. Although IAPS images have been standardised it is likely that due to idiosyncratic preferences some images categorised as “pleasant” could be found unpleasant by some individuals. To overcome this limitation and ensure that it does not confound the selection of images for the anticipatory phase, IAPS images were selected from the top and bottom quartiles of each individual’s

ratings for their participation in the study. This tailored the images selected to the individual's preferences which is novel in this field and improved on previous studies by removing this potential confound from the paradigm. If standardised scores were used to select images instead of the participant's ratings then the same image could produce very different anticipatory ratings across different participants due to their idiosyncratic preferences. This could confound the ratings when averaged across the groups. The ability to tailor the images to overcome this limitation is another benefit of using an experimental paradigm which affords a high level of control over the stimuli presented to participants.

The influential affective circumplex model (Barrett & Bliss-Moreau, 2009; Russell, 1980) posits that all affective states arise from cognitive interpretation and integration of two distinct neurophysiological systems: *valence* and *arousal*. Valence is experienced on a pleasure-displeasure continuum and arousal is a state of alertness (calm-excited). Each emotion is understood as a linear combination of these two dimensions at varying levels. For example, disgust is experienced as extreme displeasure (or very low valence) and very high levels of arousal (Posner, Russell, & Peterson, 2005). Anticipatory and consummatory pleasure are measured using a valence scale but it was important to assess arousal as well to capture the emotional experience more fully. These two components were rated using Likert scales when assessing emotional responses to stimuli and have been used in many experimental studies (Cohen & Minor, 2010; Llerena et al., 2012). A self-report measure of mood was included alongside the task as previous findings have suggested it may influence valence and arousal in non-clinical participants (Larson, Gray, Clayson, Jones, & Kirwan, 2013).

3.1.2 Computer Task Procedure

3.1.2.1 Phase 1 Rating Scales

The participant was presented with images from neutral, pleasant physical and pleasant social categories and asked to rate their subjective emotional response to each one producing consummatory pleasure ratings. Valence is defined as how pleasant the image is and was rated on a 9-point Likert scale from unpleasant-pleasant. Arousal is defined as the

strength of the emotional response to the image. Participants rated arousal on a 9-point Likert scale, as used in previous research (Heerey & Gold, 2007).

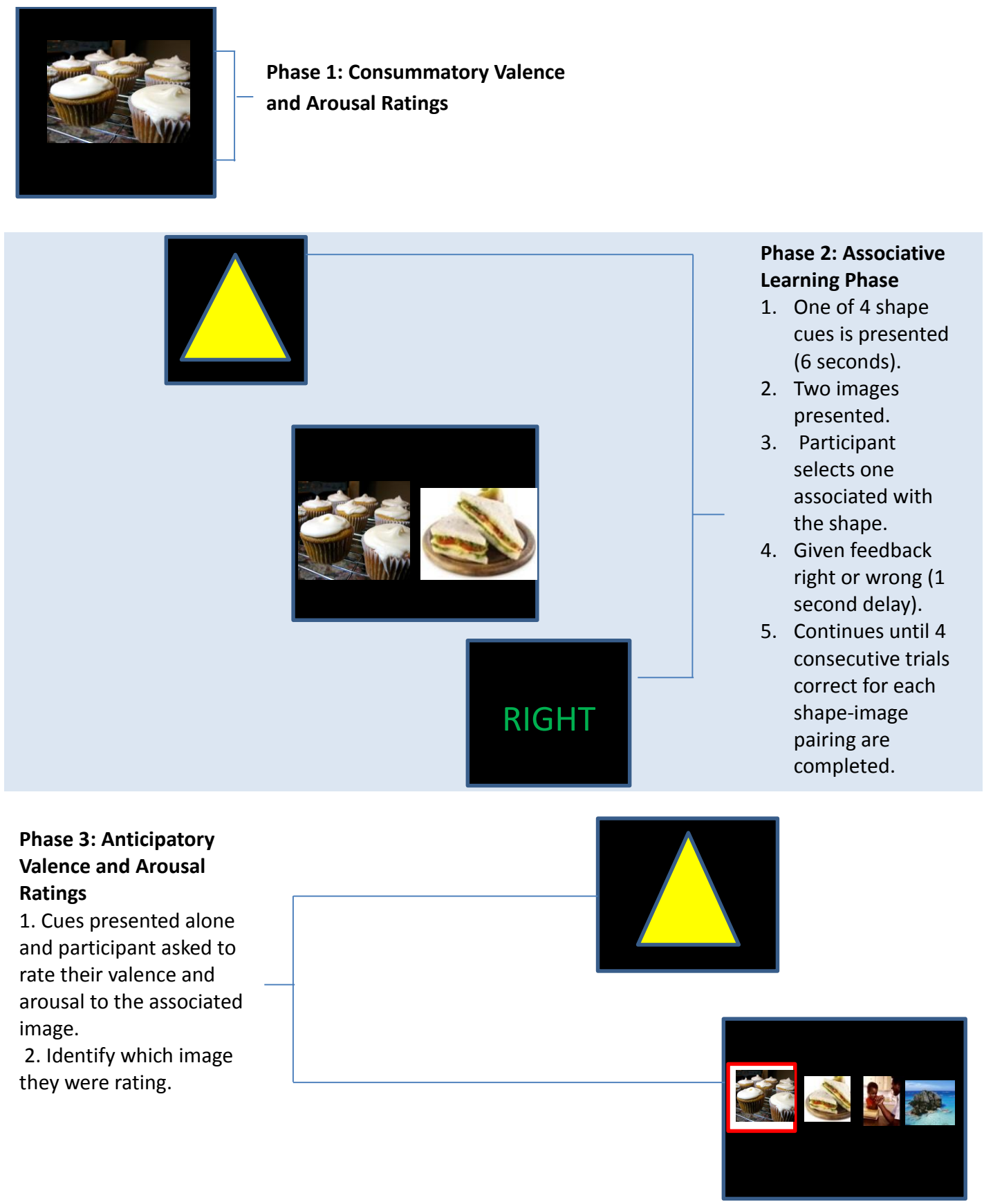
3.1.2.2 Phase 2 Learning Phase

The pleasant images presented to each participant were ordered using the valence ratings to control for the pleasantness of those chosen, and 4 images - 2 physical and 2 social - were each selected randomly by the software from the top and bottom quartiles of these valence ratings. The selection of these images also allowed the pleasure ratings given for images which were highly pleasant for an individual to be compared with those given low pleasantness ratings by that person. Each of these 4 images was then associated with a unique and emotionally-neutral cue which varied in two dimensions: shape and colour (see Figure 5). A learning aid that depicted the aim of the learning phase, which is to match each shape with an image, was given to every participant on an A4 sheet during the learning phase of the COP task (see Appendix 10).

3.1.2.3 Phase 3 Testing Phase

In the final phase of the study the participant was presented with each cue and asked to predict valence and arousal of the associated image using the same scales as in Phase 1. This produced a measure of anticipatory pleasure. They were then asked to select the image they were rating from the 4 possible options. This controlled for any difficulty learning associations as only trials where the participant had the correct image in mind were used in the analyses.

Figure 5: Components of pleasure task: diagram of the three phases - see Appendices 8 and 9 for screenshots of the COP task



3.1.3 COP Task Pilot Study

3.1.3.1 Aims

There were two aims of the pilot study:

- (i) To select images which were consistently rated for inclusion in each category: pleasant social, pleasant physical and neutral (Figure 6).
- (ii) To develop a learning paradigm which minimised cognitive load and produced sufficient learning for the majority of participants to pass the learning threshold.

3.1.3.2 Sample

All the people who took part in the pilot study were recruited by opportunity sampling and had no current mental health problems.

3.1.3.3 Methodology

There were two phases to the study: the first was image selection and the second was the development of the learning phase. The task was programmed in Microsoft Visual Basic 6.0. This program allows easy manipulation of the different components of the task e.g. images, number of trials.

3.1.3.4 Selection of Computer Task Images

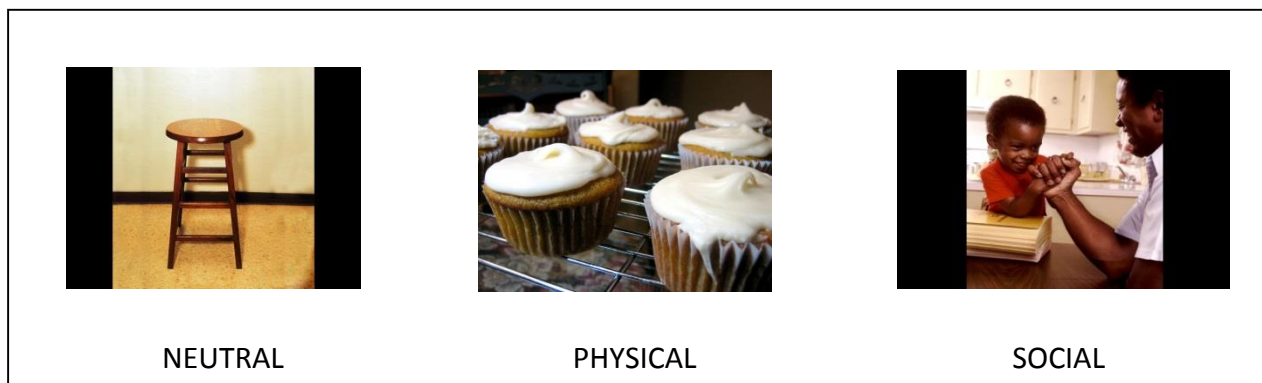
Images defined as pleasant in the IAPS catalogue were selected from the entire IAPS list (n=330). Social images were defined as any image depicting more than one person interacting and 85 such images were selected from the pleasant image pool. Physical images did not include any people. Each participant was expected to take a maximum of 10-20 seconds to rate each image, thus 90 images would take between 15 and 30 minutes to complete. Forty images per category were chosen so that ratings provided during piloting would allow a reduction to 30. The 40 images chosen for the social category were those of

the 85 identified in the IAPS catalogue that had the highest standardised valence scores (see Table 7). For the physical (non-social) pleasant category 40 from the 245 images were also selected using the highest standardised IAPS valence scores for the pilot study (see Table 7). There were no significant differences between the valence and arousal scores in the physical and social categories (Valence $t(78) = 0.30$, $p > .05$, Arousal $t(78) = 0.36$, $p > .05$). Forty images were selected at random from the 190 identified as neutral images in the IAPS list (see Table 7). As expected, average valence and arousal ratings for neutral images were significantly lower than for physical or social categories (Social Valence $t(78) = 7.12$ Arousal $t(78) = 2.53$ $p < .05$, Physical Valence $t(78) = 6.79$ Arousal $t(78) = 2.06$ $p < .05$).

Table 7: The standard ratings (9-point Likert scales) from the IAPS list for the three different types of image included in the study

IAPS Image Type (n=40)	Valence Mean(SD)	Arousal Mean (SD)
Pleasant Social	7.57 (1.51)	4.90 (2.30)
Pleasant Physical	7.47 (1.52)	4.71 (2.46)
Neutral	5.28 (1.37)	3.67 (2.04)

Figure 6: Examples of neutral, physical and social images from the IAPS catalogue



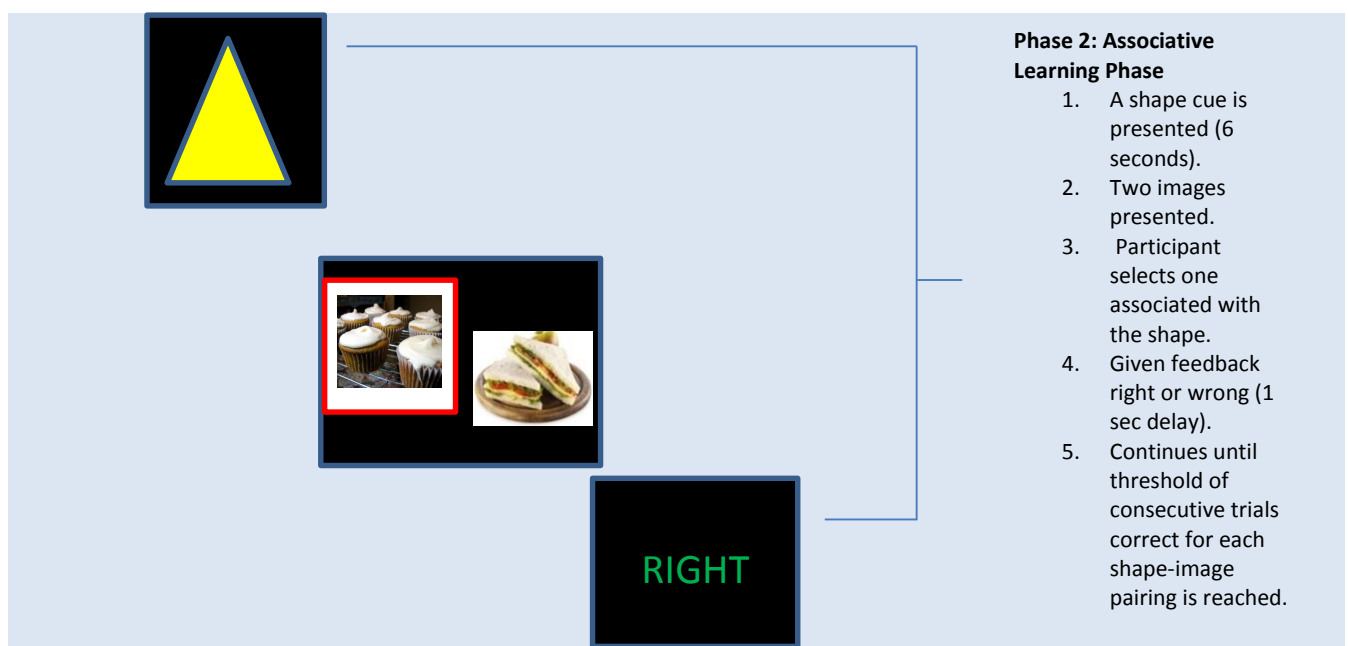
Participants were then presented with these 120 images on a 17" computer screen. They rated valence and arousal for each image and were asked to categorise it as physical-pleasant, social-pleasant or neutral (see Appendix 3 for ratings questionnaire). Each of the 30 images in a category was selected based on a consistent rating i.e. rated as belonging to that category by at least 3 of the 5 control participants. To confirm the validity of the

categories the valence and arousal of the physical-pleasant and social-pleasant images were each compared with the neutral images.

3.1.3.5 Learning Phase Development

The learning phase development part of the study involved the participants completing the entire COP task using the images selected in the previous pilot phase. The experience of taking part was monitored carefully by the researcher and participants were asked to provide verbal feedback. The number of trials needed to pass the learning threshold, time taken to do so and the number of participants who failed to pass the threshold were recorded. A flexible approach to the learning threshold was taken to gain the maximum benefit from the pilot study (see Figures 7 and 8). If participants found it difficult to pass the learning threshold it was reduced with the aim of minimising cognitive load. This new reduced threshold was then tested in further control participants in order to ensure that the majority (>90%) were passing the threshold. It was important that the majority of controls were able to pass the learning phase in a short amount of time as individuals with schizophrenia would be likely to find this substantially more difficult and require more trials. Initially the learning phase involved matching a unique shape to each of 8 images and the learning threshold was set to six consecutive trials in which each shape-image pairing was identified correctly.

Figure 7: Diagram of learning phase of the COP task



Consummatory image ratings given by all the participants in the consummatory phase were recorded and compared to standardised ratings for each IAPS image. Neutral and pleasant categories were also compared to each other to confirm validity of the images selected in a larger population.

3.1.3.6 Results

Five participants took part in the image selection phase of the pilot study. A further 17 participants took part in the learning phase development.

3.1.3.7 Image Selection

As expected, valence was significantly lower for neutral images when compared to both sets of pleasant images but there was no difference in arousal (Physical vs. Neutral Valence $t(4) = 2.5$; Social vs. Neutral Valence $t(4) = 4.1$, $p > .05$; Physical vs. Neutral Arousal $t(4) = 0.31$; Social vs. Neutral Arousal $t(4) = 0.95$, $p < .05$) (Table 8). There was no significant difference between the ratings for the pleasant social and pleasant physical images ($t(4) = 1.51$, $p > .05$). Ratings were repeated in a larger sample in the next phase of the pilot study. The full selection of images used in the task is detailed in Appendices 5-7.

Table 8: The preliminary pilot valence and arousal ratings (9-point Likert scales) for the 90 images included in the study

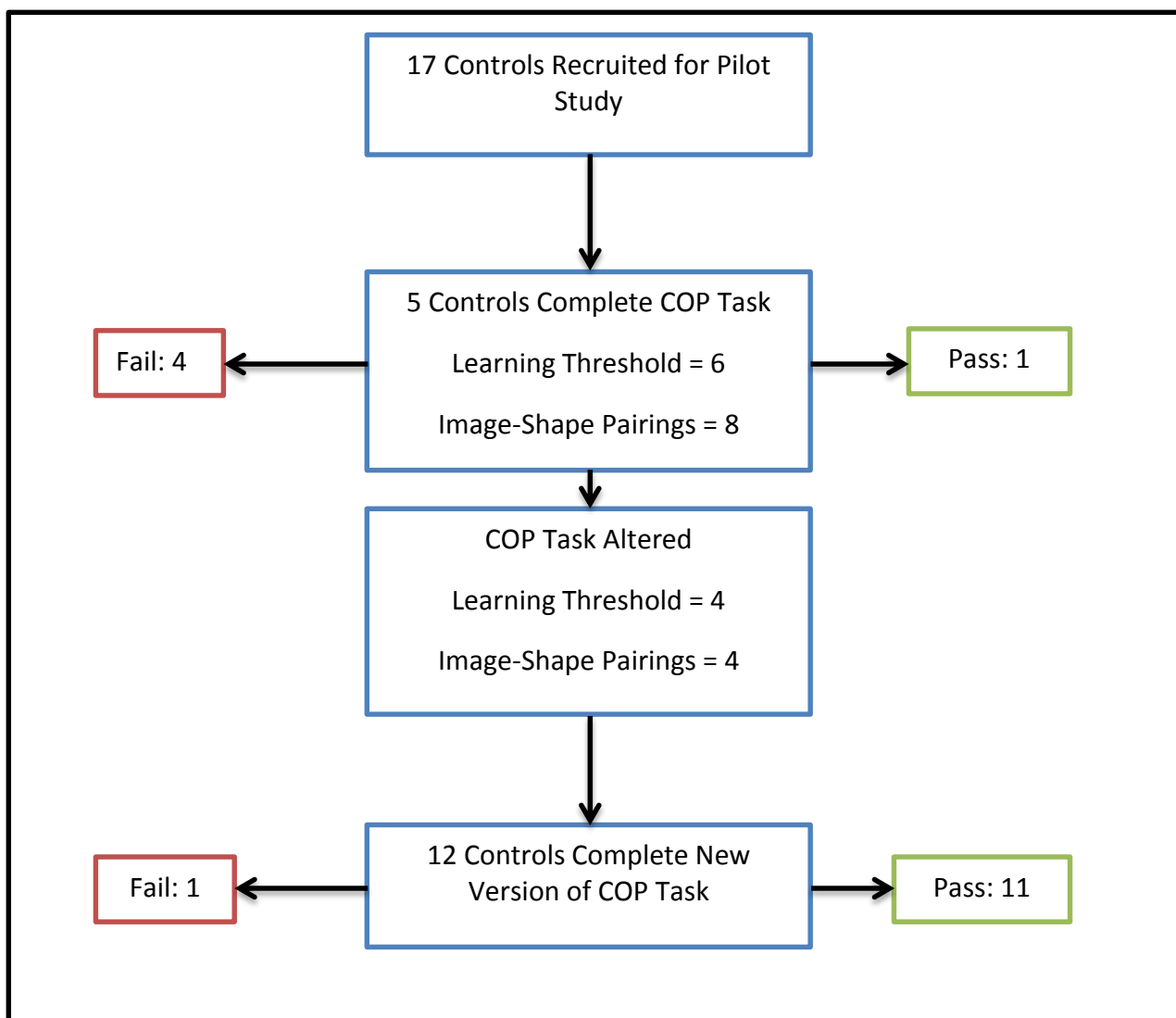
IAPS Image Type (n=30)	Pilot Valence Mean (SD) (n=5)	Pilot Arousal Mean (SD) (n=5)
Pleasant Social	7.27(0.95)	5.11(1.88)
Pleasant Physical	6.25(1.16)	4.37(1.90)
Neutral	4.33(1.29)	4.02(1.70)

3.1.3.8 Learning Phase Development

Four of the first 5 participants to complete the pilot did not pass the learning threshold and reported finding it very difficult and the task too long (>40mins) (see Figure 8). As this task is designed for use in a population of individuals with schizophrenia who

often experience cognitive difficulties (N. F. Forbes et al., 2009), the failure rate in control participants was considered too high. The task was therefore adapted to reduce cognitive load by halving the number of pairings so that each image category was represented once (4 images used in total). The learning threshold was set at four consecutive trials correct for each image. Eleven out of twelve control participants achieved this new threshold level (average 4.55 (SD=.93) trials to learn). To ensure participants were not overly burdened an upper limit of 12 attempts per pairing was set during this phase.

Figure 8: Consort diagram of learning phase development pilot study



No difference was found between standardised ratings of the IAPS images included and those provided by the pilot sample (Social Valence $t(16) = 1.51$ Arousal $t(16) = 0.42$,

Physical Valence $t(16) = 1.57$ Arousal $t(16) = 0.01$, Neutral Valence $t(16) = 1.75$ Arousal $t(16) = 0.38$, $p > .05$) (see Table 9). There was also no difference between the two pleasant image categories in valence ($t(13) = .812$, $p = .43$) or arousal ($t(13) = 1.43$, $p = .18$). The neutral category showed significantly lower valence (Physical $t(13) = -7.00$, $p = .0001$; Social $t(13) = -6.76$, $p = .0001$) and arousal (Physical $t(13) = 2.38$, $p = .033$; Social $t(13) = -3.10$, $p = .01$) than the pleasant images. Every individual completed the ratings in less than 30 minutes which was considered acceptable.

Table 9: Full pilot and standard consummatory valence and arousal ratings (9-point Likert scales)

Type of Image (n=30)	Pilot Valence Mean (SD) (n=14)	Pilot Arousal Mean (SD) (n=14)	Standard Valence Mean (SD)	Standard Arousal Mean (SD)
Pleasant Social	6.93 (0.64)	5.13 (1.45)	7.57 (1.52)	4.84 (2.29)
Pleasant Physical	6.82 (0.53)	4.68 (0.88)	7.47 (1.52)	4.68 (2.46)
Neutral	4.40 (1.04)	3.76 (1.00)	5.16 (1.32)	3.53 (2.04)

3.1.3.9 Service User Consultation

The final stage of the task development was consultation with the Service User Advisory Group (SUAG) led by Professor Diana Rose from the Service User Research Enterprise (SURE) (Rose & Wykes, 2001). The aim of SURE is to collaborate with service-users in all stages of research. SUAG is part of a wider service user advisory initiative aimed at ensuring research is accessible to service users and not overly burdensome. The format of the computer task was presented to the members of the group and feedback on images, instructions and potential burden on participants was received through discussion with members of SUAG. This resulted in a change to the presentation of the instructions with an increased emphasis on rating their initial reaction to, or “gut feelings”, about the images. The order of the questionnaires was also altered to allow the session to be divided into two if necessary. Members of SUAG confirmed that the images were acceptable and not distressing. The study protocol, information sheet and consent forms were then reviewed by the Feasibility and Support to Timely recruitment for Research (FAST-R) service which

offers service-user input into study design. After amendments were made to the language, the service user reviewers approved all of these documents.

3.1.3.10 Discussion and Implications for COP Task Development

The desired pattern of responses was present in the image selection phase; higher valence for pleasant social and pleasant physical compared to neutral and no difference between the two pleasant image categories. The majority of participants passed the adapted learning threshold with ease suggesting that the aim of minimising cognitive load had been reached at this level in the COP task. The aims of the pilot study were achieved, the protocol was reviewed and approved by SUAG and the task was used in this form in the final study.

3.2 Experience Sampling

3.2.1 Rationale

Experience sampling was developed to overcome the limitations of experimental paradigms and to enable researchers to gather data from an individual's everyday life. As discussed previously, the use of both an experimental (COP task) and observational approach (ESM) allows for a thorough assessment of the anticipatory pleasure deficit hypothesis. ESM has also been shown to be feasible when studying emotional responses in individuals with schizophrenia (Gard et al., 2007; McCormick et al., 2012). Experience sampling provides a unique opportunity to assess activity levels in everyday life. This enabled the pathway from reduced anticipatory pleasure to reduced engagement in activity proposed by the TEP model (Kring & Caponigro, 2010) to be investigated.

To assess this pathway thoroughly all components need to be measured: anticipatory pleasure (emotion), expectation, motivation and activity. ESM allowed this to be examined over time so that the pathway could be tested longitudinally as well as cross-sectionally, increasing the robustness of the findings. This was possible because participants could be asked about their motivation, pleasure and expectation prospectively i.e. in relation to a future event or activity. As questionnaires were completed at several time-

points each day, prospective ratings could be entered into a model as predictors for an event which occurs at the next time-point. ESM addresses some of the limitations of the COP task such as the somewhat artificial stimuli and environment. It also allows for a more complete and temporal assessment of the anticipatory pleasure deficit hypothesis. For these reasons it was selected as the methodology for use in this study.

3.2.2 ESM Questionnaire Development

Previous studies have used up to 10 questionnaires per day in the experience sampling literature but this could over-burden the clinical group (Kimhy et al., 2012). This is of particular concern in this study as these individuals are recruited based on high levels of negative symptoms including low motivation and energy levels, which may present an additional barrier to completing the questionnaires. Other studies have used 4 questionnaires per day (Granholt et al., 2008) but this was considered too few to gain an accurate picture of a full day. The frequency of 7 questionnaires per day was selected for this study to gain a picture of a full day and as the mid-point between 4 and 10. Previous studies have found this to be feasible in outpatient populations of people with schizophrenia (Ben-Zeev, Morris, Swendsen, & Granholt, 2012; McCormick et al., 2012).

The full ESM questionnaire used in the study is detailed in Figure 9 below. The first stage of developing the ESM questionnaire was to select activities to be included in the items. Leisure activities, functional activities and social interactions were included in the questionnaire as they appear to be important from previous research and are all key outcomes for interventions (Gard et al., 2007; Gard, Sanchez, Cooper, et al., 2014; Granholt, Ben-Zeev, Fulford, & Swendsen, 2013; Keefe, 2014). Participants were asked to choose between 10 categories: relaxing, housework, shopping, work/school, studying, hygiene, travelling, leisure activity, eating/drinking and nothing. The instructions given to the participant were to select the category that best represented their current activity for the consummatory item. For the anticipatory item they were asked to select a category of activity they were likely to be doing in the next couple of hours (see Figure 9). They were asked to select “nothing” only when they felt they weren’t resting and weren’t currently engaged in any activity listed. Resting was described as a passive leisure activity e.g. having the TV or radio on in the background; active leisure activities e.g. going to a café were

described as “leisure”. Functional activities included travelling, housework, shopping, hygiene, eating/drinking, work and study.

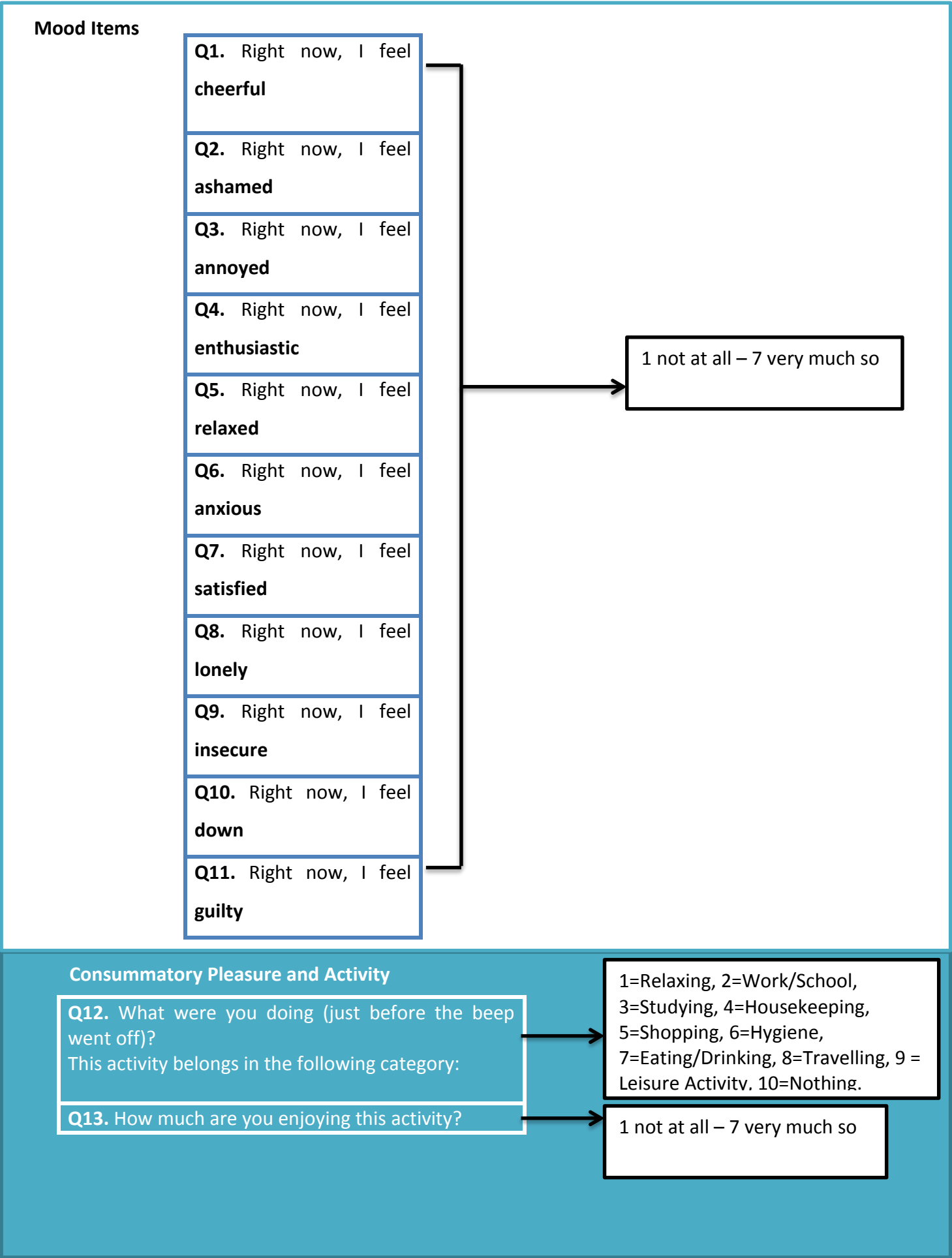
Items assessing anticipatory components of the TEP model: anticipatory pleasure, expectation and motivation were also included. Additionally, consummatory pleasure was measured during each activity to attempt to replicate the finding that this is intact from previous experience sampling studies (Gard, Sanchez, Cooper, et al., 2014). It was also considered important to examine the link between consummatory and anticipatory pleasure in everyday life which is currently unclear, although at least one study suggests that it may be weaker in people with schizophrenia compared to controls (Trémeau et al., 2010). Consummatory and anticipatory pleasure were rated on a 7-point Likert scale from 1 not at all to 7 very much so – “How much are you enjoying this activity?” and “How much do you think you will enjoy this activity?” Motivation was rated using the sum of two items related to the anticipated activity - “How interested are you in this activity?”, “Would you prefer to do something else?” The questionnaire also contained an item assessing expectation- “What do you think are the chances this activity will occur?” rated from 0-100%, which was coded in 10% intervals from 1-10.

Specific hypotheses have been proposed regarding social deficits, and therefore specific social questions were included to ensure that this research question was examined separately. Participants were asked who they were with and for their consummatory pleasure rating of that experience. They were then asked prospective questions about their anticipatory pleasure for future social activities which was hypothesised to be distinct from ratings related to non-social activity (Gard, Sanchez, Starr, et al., 2014; Radke, Pfersmann, & Derntl, 2015). Socialising was assessed by selecting current and future social contact from 7 categories grouped into familiar (partner, friends, family, colleagues, and acquaintances), unfamiliar (strangers) and nobody. Current and future enjoyment of social contact was rated on a 7-point Likert scale and there was also a rating of preference to be alone/with others - the questionnaire branched to ensure the participants were asked the appropriate set of questions based on their current company (see Figure 9).

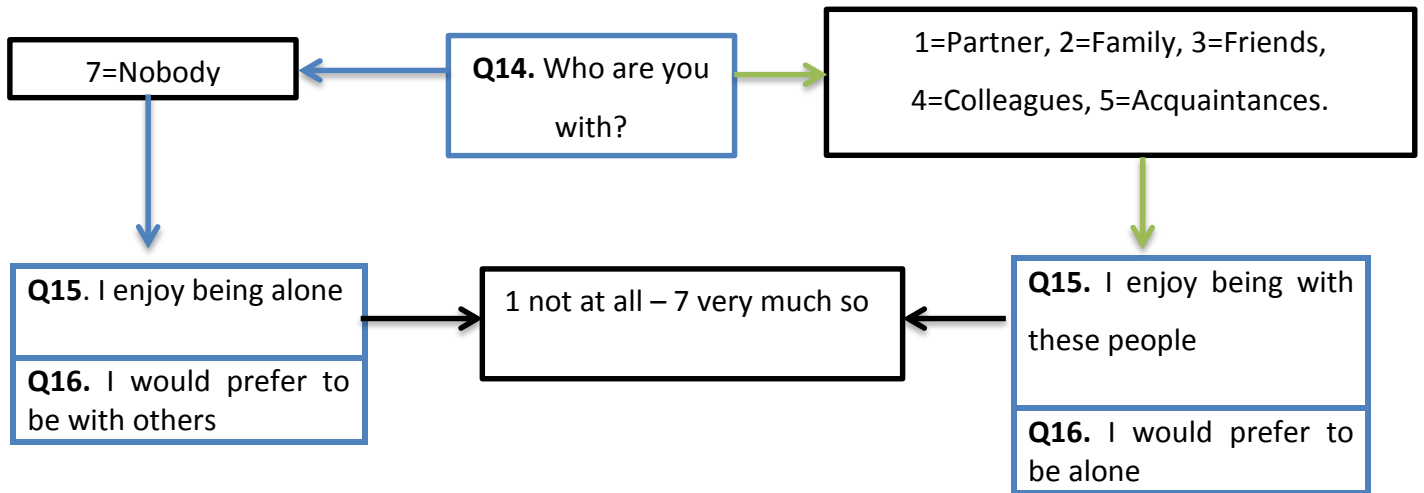
Mood is indicated as an important consideration in the healthy control literature (Wilson & Gilbert, 2005) but its role in the pathway proposed in the TEP model is currently

unclear. Mood was assessed in the ESM questionnaire by rating 11 feeling states e.g. "Right now I feel [guilty]". Four of these items were grouped into a positive affect rating and the remaining 7 into a negative affect rating. Negative and positive affect were measured at each time-point to examine whether they had an impact on the link between anticipatory pleasure and activity.

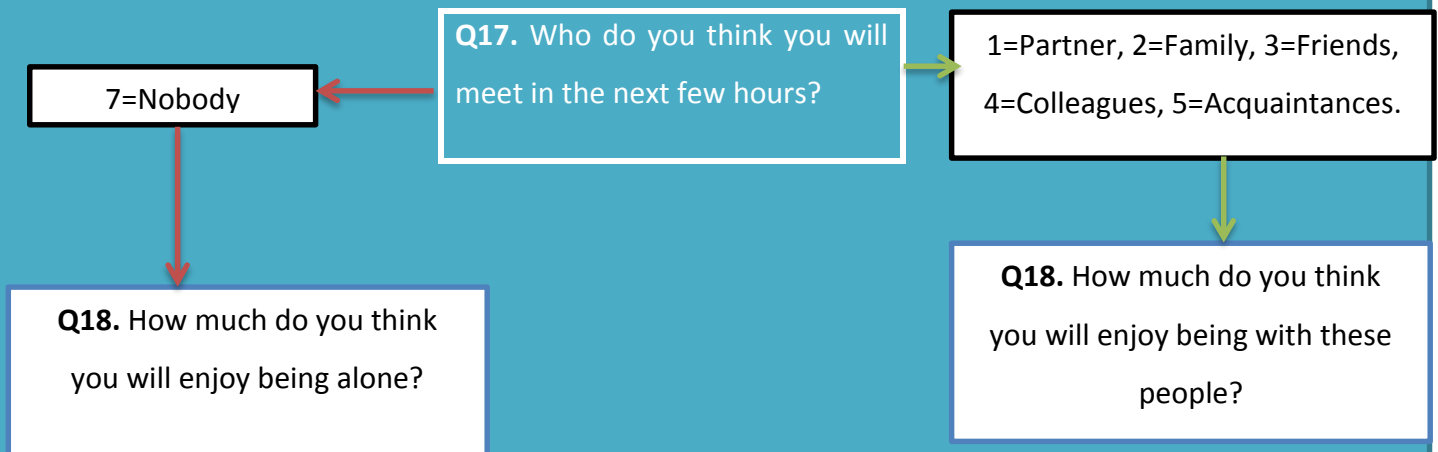
Figure 9: ESM questionnaire: items and branching (see Appendix 12 for screenshots of questionnaire items)



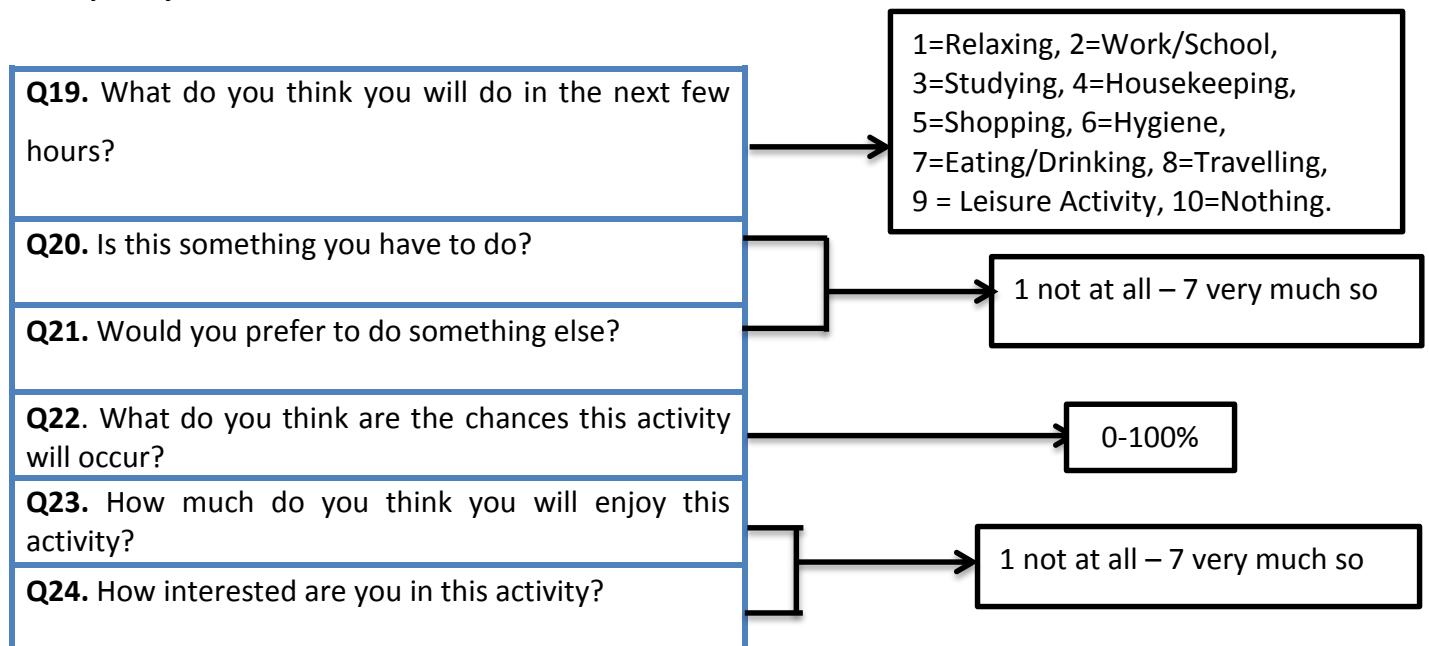
Social Consummatory Pleasure



Social Anticipatory Pleasure



Anticipatory Pleasure and Motivation



3.2.3 Devices

The PsyMate was selected to administer the questionnaire in the study (Boyce, 2011; Maastricht University). This is a purpose-made device which allows more flexibility in programming than a PDA. It reduces the burden on participants compared to the wristwatch and booklet method which could be less convenient as both the watch and the booklet needed to be carried with the participant at all times (Palmier-Claus et al., 2011). It is also small and can fit into a pocket or bag easily. It can be programmed to generate beeps at random times of the day with prompts appearing on a touch-screen (see Figure 10). The PsyMate battery lasts for at least 7 days so did not require charging and it can store data obtained in a week, so there was no need for the participant to perform any uploads during the study. All data from the PsyMates is uploaded to an online database (4D, 2010) by the researcher when it is returned by the participant. This output allows data manipulation which can then be exported to statistical software programs to conduct analyses.

Figure 10: PsyMate device



3.2.4 Experience Sampling Methodology Protocol

All participants who completed both components of the computer task successfully were given the opportunity to take part in the experience sampling study (Figure 11). There are 3 phases in the experience sampling protocol.

3.2.4.1 Phase 1 Briefing Session

Each participant was given a training session on the handheld device. They were also fully briefed on the frequency of the beeps and given the opportunity to ask questions. It was important during this session that any concerns the participant had were discussed e.g. filling out the questionnaire in a social situation.

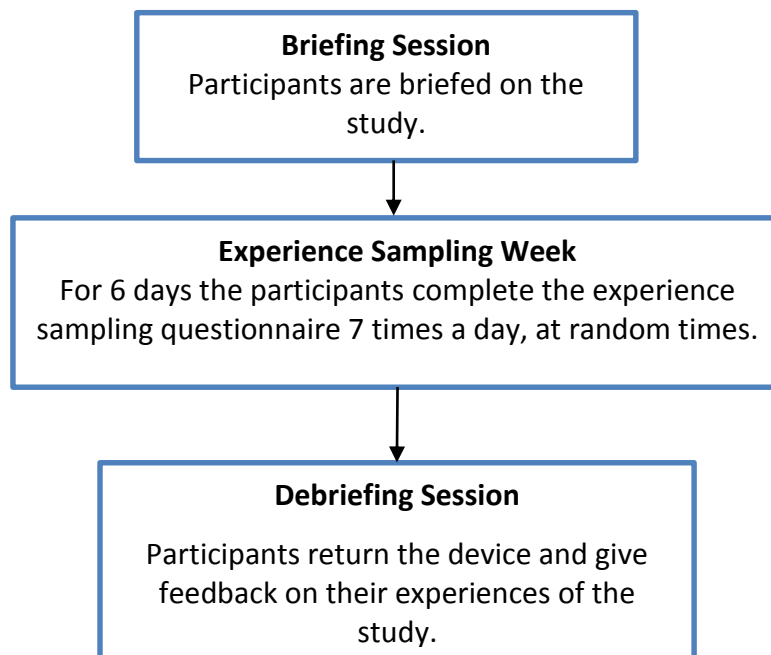
3.2.4.2 Phase 2 Experience Sampling Study

The handheld device (PsyMate) beeped (or vibrated if on silent) 7 times a day. These events occurred at pseudorandom times, at least 45 minutes apart, between 8.30am and 10pm each day for 6 days; in accordance with standard protocols used in ESM studies e.g. Kimhy et al. (2012). At each beep the handheld device presented the participant with the questionnaire to complete within 20 minutes. The researcher called the participant at two time-points during the data collection week to check their progress and give them the opportunity to ask any questions.

3.2.4.3 Phase 3 Debriefing Session

Each participant attended a debriefing session at the end of the week (after day 6) to return the handheld device. This was also an opportunity for the researcher to answer any questions they may have. During the debriefing session of the ESM study participants completed a feasibility questionnaire that included items such as “I enjoyed the experience sampling week” and “I found it easy to remember to take the PsyMate with me” which assessed how feasible and acceptable this method was in the groups.

Figure 11: Experience sampling protocol overview



3.2.5 Experience Sampling Pilot Study

3.2.5.1 Aims

The overall aim of this study was to assess the feasibility and acceptability of this protocol.

3.2.5.2 Sample

All participants were recruited for the pilot study by opportunity sampling and had no current mental health problems.

3.2.5.3 Methodology

Participants completed the protocol as described above, including the feedback questionnaire in the final session. Every participant was contacted during their time using the PsyMate to ensure it was not causing distress. The feedback questionnaires were reviewed regularly by the researcher as the pilot progressed. Had any distress been reported during the week or disclosed in a questionnaire, the study would have been

stopped pending further investigation and potential methodology adjustments. The feedback questionnaire asks participants to rate how much they agree with several statements about their experience from 1 (not at all) to 7 (very much so).

3.2.5.4 Results

Ten participants took part in the pilot study and 7 of these individuals returned completed ESM feedback questionnaires. No changes were made to the items in the questionnaire as all the participants found it to be clear and comprehensive but changes were made to the briefing session protocol and how participants were trained to use the device. Firstly, several participants raised concerns that the questionnaires were easy to miss if the device was set to silent so it was recommended that participants keep it in loud mode as much as possible. The second change was to add some additional guidance about social situations to the training session as some people found it uncomfortable to complete the questionnaire in company and felt they needed a bit more encouragement and rationale as to why it was important to do so. Responses to the feedback questionnaire are summarised in Table 10. Participants reported that the briefing session provided adequate training for the week, that the questionnaire and device were user-friendly, and that taking part in the study did not disrupt everyday life.

Table 10: Average agreement scores for each statement in the experience sampling feasibility questionnaire. Each item was rated on a 7-point Likert scale from 1 (not at all) to 7 (very much so)

Statement	Agreement Score Mean (SD) (n=7)
The experience sampling device disrupted my everyday life.	2.14 (1.07)
The questionnaire was easy to complete	6.0 (.82)
At times I had to rush to complete the questionnaire.	4.0 (1.83)
The experience sampling device stopped me from doing my usual activities.	1.0 (0.0)
I found it embarrassing when the alarm sounded around other people.	1.57 (.79)
I found it easy to remember to carry the experience sampling device with me.	5.57 (1.27)
The training I received in the briefing session was adequate to use the device for the whole week.	6.71 (.49)
I felt supported by the research team during the experience sampling week.	7 (0.0)
I enjoyed the experience sampling week.	4.39 (1.38)
The experience sampling device changed my usual routine.	1.14 (.38)

3.2.5.5 Implications for ESM Study

The findings from the pilot study were that the protocol for the ESM study did not generate high levels of disruption and the participants completed questionnaires during a typical week. This supports the validity of this questionnaire and protocol. Participants also reported the experience of taking part as acceptable which is encouraging for the full study. The pilot study also offered the opportunity to check for any technical problems and any issues that arose were resolved in partnership with Maastricht University which supported the programming of the devices.

3.2.6 Service User Consultation

SUAG was asked for feedback on the potential burden for participants when completing the ESM study. The feedback suggested that the participant burden was acceptable and the devices were easy to use. The group felt it was important to emphasise to potential participants that there was no GPS tracking in the device as this might be a concern for participants. Appropriate changes were made to the protocol to make this clear to participants. The information sheet, questionnaire and protocol for this part of the study were also reviewed and approved by the FAST-R service. The protocol was used in this form in all subsequent studies.

3.3 Ethical Considerations

3.8.1 Consent

As discussed below in the Recruitment Protocol section of this chapter (Page 109), participants initially provided consent for the researcher to contact them. This was either via a member of their care team, a Negative Symptoms of Schizophrenia (NESS) research worker, or in the case of the control group by responding to an advertisement. Participants in both groups were offered the information sheet prior to the appointment and everybody received a hard copy in the first session. It was ensured that all participants were given time to consider their participation and consult others if they wished. The consent form was presented in written form but also explained verbally by the researcher, and any questions were addressed before the consent process continued. Participants signed the consent form before taking part in any components of the study and were told they could withdraw their consent at any time. If at any stage in this process the researcher became concerned that an individual did not have capacity to consent the process was halted and this was discussed with the participant's care co-ordinator and the research supervisor. If concerns about capacity were shared with these professionals then the individual was not consented to take part in the study.

3.3.2 Confidentiality

All participants who took part in the study were assigned anonymised study codes which were used to label both questionnaires and computer task data. All information relating to de-anonymising the codes and the consent forms was locked away from all data. This was explained to participants before consent forms were completed. The people with schizophrenia were reminded that whilst all information provided was treated as confidential an exception would have to be made if they said anything which caused the researcher to be concerned about them or somebody else. Once this was understood the researcher proceeded with the interviews. Medical records of participants in the clinical group were consulted for medication details and diagnoses. A section of the consent form gives permission for the researcher to have access to the records and the purpose of this was explained to the participants. These standards are in line with Good Clinical Practice (GCP) guidelines on studies with human subjects in the UK (Vijayananthan & Nawawi, 2008). CE attended a GCP training course to ensure that these standards were maintained throughout the study.

3.3.3 Burden

Clinical participants were recruited after their participation in a clinical trial of body psychotherapy (Priebe et al., 2013) which could raise concerns that they were being overburdened by research. To minimise the burden patients were contacted regarding this study only when they were not actively participating in the clinical trial. The initial testing session could be considered quite long in duration, especially for the clinical group as additional clinical interviews were completed. Participants were offered a break after completing the computer task, approximately 30-45 minutes into the session, and again before the clinical interviews. This broke the session into more manageable chunks of approximately 45 minutes. The experience sampling week involves carrying a device for 6 days and answering 7 short questionnaires a day. Again, this might be considered a substantial amount of time for the individual to be interacting with the device. However, as each questionnaire takes approx. 2 minutes to complete, this adds up to 14 minutes a day. To minimise the burden,

the participants were called at least twice during the week to ensure that they were not having any difficulties and were encouraged to call the researcher should any questions or problems arise.

3.4 Total Sample

3.4.1 Schizophrenia (SZ) Group

Inclusion criteria:

1. A diagnosis of schizophrenia according to DSM-IV criteria, confirmed using the Structured Clinical Interview for DSM Disorders checklist (First, 2002) and via clinical records;
2. Aged between 18-65 years;
3. The participants had a score of at least 14 on the PANSS negative subscale (Kay et al., 1987). This level ensures that negative symptoms are present but also allows a wide range of symptom levels to be studied and has been used in previous research for these reasons (Lysaker & Bell, 1995); and
4. Participants must have a good command of English.

Exclusion criteria:

1. A primary diagnosis of substance abuse disorder recorded in the clinical records of the individual; or
2. Significant learning difficulties recorded in the clinical records of the individual.

3.4.2 Control Group

Inclusion criteria:

1. No history of or current psychiatric disorder as assessed by the Mini International Neuropsychiatric Interview (Sheehan et al., 1998).
2. Aged 18-65yrs; and
3. Participants must have a good command of English.

Throughout this thesis the use of the word “controls” refers to individuals recruited according to these criteria.

3.4.3 Recruitment Procedure

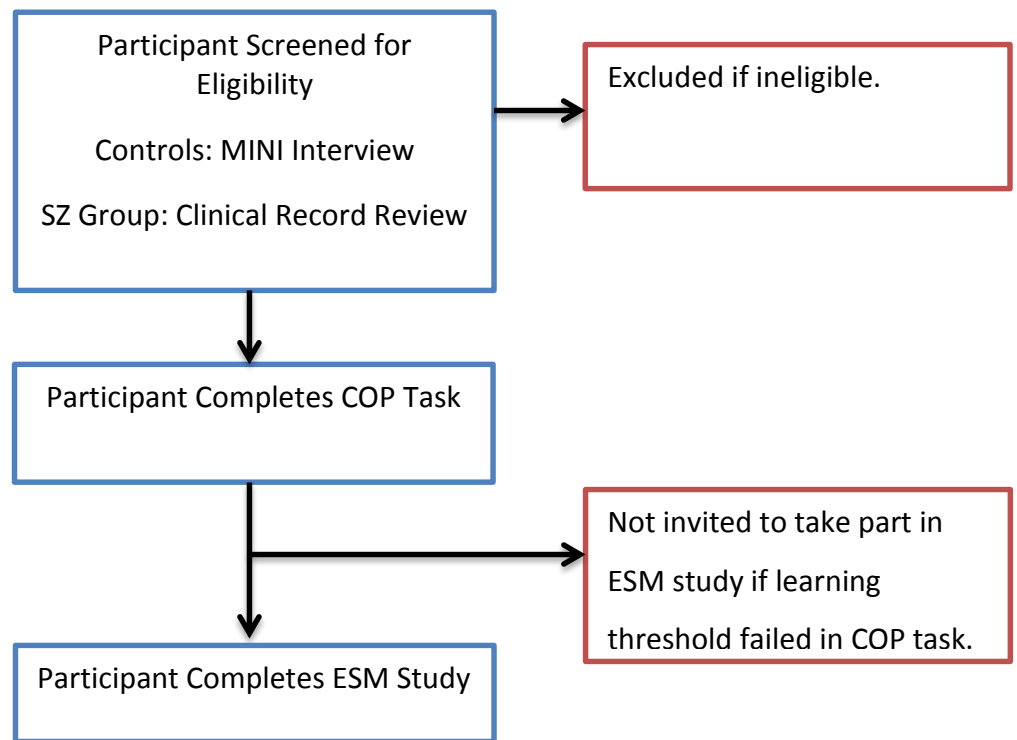
Participants were recruited alongside the Negative Symptoms of Schizophrenia (NESS) body psychotherapy trial conducted by Professor Til Wykes (1st academic supervisor) at the Institute of Psychiatry (Priebe et al., 2013). Participants were recruited for this trial from Community Mental Health Teams (CMHTs) in all four boroughs in the South London and Maudsley (SLaM) NHS Trust; Lambeth, Lewisham, Croydon and Southwark. Care-coordinators in these CMHTs were briefed on the trial, specifically the eligibility criterion of a PANSS negative subscale score of at least 18, and asked to refer people who were experiencing difficulties with negative symptoms. Participants were approached once they had completed their participation in the NESS trial or if they were ineligible for NESS for reasons that did not preclude them from taking part in this study (e.g. time commitments, PANSS negative subscale score 14-18). A research worker from the NESS trial then introduced this study and asked if they would consent to receiving a phone call from the researcher with further details. Participants who consented to this were contacted via telephone, given further information and asked if they would be willing to meet with the researcher to discuss their participation in the study. The researcher also offered to post them the information sheet to consider prior to an appointment.

Control participants were recruited through MindSearch (volunteer record), advertising on online recruitment websites (www.experimatch.com, www.gumtree.com) and email to the King's College London staff and students' communities. Individuals who expressed interest were emailed the information sheet to consider and asked to confirm that they were happy to be interviewed on the telephone before meeting with the researcher. Once consent was received the researcher conducted screening on the telephone to ensure that they did not have a history of or current psychiatric illness.

During the first meeting all participants were given a hard copy of the information sheet, and had time to consider the information and ask questions before completing the consent form together with the researcher. Participants who completed both the anticipatory and consummatory phases in the computer task session were invited to take part in the experience sampling phase of the study (see Figure 12). This inclusion criterion was added as planned analyses included anticipatory ratings from *both* the COP task and

ESM study. Participants were reimbursed £5 per hour for their time in computer task sessions and a further £40 for taking part in the experience sampling study. The progress of participants through the study is detailed in the flow chart below.

Figure 12: Diagram illustrating the participation in different stages of the thesis research



3.5 Power Calculations

Power calculations were performed to determine the sample size required to conduct sufficiently powered analyses. All power calculations were conducted using GPower 3.1 software (Faul, Erdfelder, Lang, & Buchner, 2007). Power was set at 0.8, $\alpha = 0.05$ and all tests were for two-tailed hypotheses. These criteria are in line with other studies conducted in the field of psychology research (Field, 2009).

3.5.1 Chapter 5: Reliability and Validity of the COP Task

This study aimed to replicate the test-retest reliability of intra-class correlations of >0.8 in previous studies using the IAPS images (Lang, Greenwald, Bradley, & Cuthbert, 1993;

H. Lee, Shackman, Jackson, & Davidson, 2009). A sample size of 16 in each group is sufficient to detect these high correlations across the two week test-retest period.

3.5.2 Chapters 4 and 6: Experimental and Self-Report Assessments of Anticipatory and Consummatory Pleasure

Analyses of Variance (ANOVAs), examining a group effect in TEPS and COP task consummatory ratings and anticipatory ratings were conducted. A one-way ANOVA was planned for Chapter 6 to identify any group effects in the anticipatory-consummatory discrepancy scores. A sample size of 45 per group was determined as sufficient to detect an effect size of 0.6 or higher in this analysis and post-hoc t-tests as reported in previous similar research (Cohen & Minor, 2010).

3.5.3 Chapter 8: Experience Sampling

Experience sampling data were analysed using multi-level linear regression models, a variant of unilevel linear regression analyses. Therefore, a power calculation was performed based on a linear multiple regression model with a random factor to give an estimate of sample size. This calculation suggested a total sample of 30 people (15 per group) would be sufficient to detect a population multiple correlation coefficient of 0.4 with up to 8 predictors with an inter-correlation of 0.5 or higher. As this calculation does not account for the clustering of data, the total sample size was increased to 40 to accommodate the high level of inter-correlation within each participant and day that may occur. This sample size is in line with previous research and recommendations in the field e.g. (Kimhy et al., 2012).

3.5.4 Chapters 4, 5, 6, 7 and 9: Correlational Analyses

Correlational analyses were conducted between self-report measures and the pleasure ratings from the COP task and ESM study. A power calculation was performed to determine the necessary sample size to detect a moderate correlation of 0.4 or higher, which has been reported between anticipatory and consummatory ratings and self-reported anhedonia in a previous experimental study (Choi et al., 2013). This calculation determined that 46 people in each group would be sufficient to detect such a correlation. A further

power analysis in G-Power revealed that this sample size would also be sufficient to detect a moderate *partial* correlation of 0.4 or higher.

3.6 Measures

3.6.1 Scales for Clinical Attributes and Functioning Only Assessed in the Clinical Group:

3.6.1.1 Positive and Negative Syndrome Scale (Kay et al., 1987)

This scale was developed to assess the positive, negative and general symptoms in schizophrenia in the form of a clinical interview. Individuals are assigned a score from 1 -7 (1 = not present, 7 = very severe) for each item in the three subscales: positive, general and negative as experienced in the last week. All PANSS assessments were conducted and scored by CE who received training in conducting PANSS interviews from senior researchers. Training consisted of listening to several recorded PANSS interviews until CE and the senior researcher reached the point where there were no disagreements between the gold standard ratings and those from CE by more than one point and never between the critical 3/4 distinction. This method of training is described in a recent study from Csipke et al. (2014).

The positive 7-item subscale includes items assessing delusional ideation, conceptual disorganisation, hostility and hallucinatory experiences. The 16-item general subscale includes depression and anxiety items as well as other associated features such as insight, impulsivity and attention difficulties. The negative subscale has seven items including 'blunted affect', 'emotional withdrawal' and passive/apathetic social withdrawal' which are included in the negative symptoms. A five-factor solution of this scale has been proposed after a review and factor analysis of the wider literature which groups the emotional or experiential negative symptom items as one factor within the PANSS separate from other negative symptoms included in the overall subscale e.g. difficulty with abstract thinking (Wallwork et al., 2012). This solution will also be used in analyses as the negative factor and depressive factor more specifically reflect emotional deficits, which are hypothesised to be linked to anticipatory pleasure. The other four subscales of the solution are disorganised,

positive, excited and depressed. The PANSS was chosen for use in the study as it is a comprehensive measure of symptomatology and includes all symptom domains that may be relevant to be assessed. It has also been widely used in the field of schizophrenia research, with good test-retest reliability across 6 months (Kay et al., 1987; Kay, Opler, & Lindenmayer, 1988).

3.6.1.2 Clinician-Assessed Interview for Negative Symptoms (CAINS) (Horan et al., 2011)

This recently developed interview assesses negative symptoms in schizophrenia. The CAINS measures several key features linked to anhedonia including anticipatory pleasure, motivation and levels of activity. It has two negative symptom factors: experiential and expressive. The experiential factor assesses enjoyment gained from experiences and anticipation of enjoyment from future experiences. This was important to assess the relationship between negative symptoms and emotional deficits. Each item is scored from 0 = no impairment to 4 = severe deficit. An experiential item requires asking the participant questions such as “Have you spent much time with your family in the last week?” and “Is having a relationship with your family important to you?” Motivation for family relationships is rated according to answers to these and further questions. The interview then asks how many pleasurable social activities have occurred in the last week and how many are expected next week. These two answers are used to rate the current and anticipated frequency of pleasurable social activities. Expressive items are rated by the interviewer based on their observations during the assessment e.g. facial expression, vocal expression. CE was trained in conducting the CAINS interview by a researcher on the NESS clinical trial using observations of previous recorded interviews. The subscales have good internal consistency, Cronbach’s $\alpha=.88$ for the expressive and $\alpha=.74$ for the experiential; these are no better than the internal consistency of the scale as a whole ($\alpha=.76$) which supports the use of these two factors (Kring et al., 2013). The CAINS items show good reliability with intra-class correlation coefficients ranging from .69-.94 for included items. It also has good test-retest reliability for expressive and experiential subscales across 2 weeks with correlations at 0.69 for both (Kring et al., 2013).

3.6.1.3 Functioning in the Clinical Group: Time Use Survey (Fowler et al., 2009; Short, 2006)

The Time Use Survey is administered in an interview format. It provides a measure of functioning by assessing how much time is spent on a range of activities. It produces two scores in hours per week: one for Constructive Economic Activity (CEA) and one for Structured Activity (SA). The CEA score includes time spent in employment, studying, housework, childcare and looking for work or education. The SA score includes the CEA score plus more recreational activities such as hobbies and socialising. The Time Use Survey provides information on activities completed and time spent in a wide range of domains including leisure and work/study. This is an advantage over other performance-based assessments or questionnaires that ask for frequency but not duration of activities. The Time Use Survey has been extensively validated in the UK general population (Gershuny, 2011; Lader, Short, & Gershuny, 2006) and in people with schizophrenia (Fowler et al., 2009).

3.6.2 Anhedonia Scale for Use in Both the Control and Clinical Populations:

3.6.2.1 Temporal Experience of Pleasure Scale (TEPS) (Gard et al., 2006)

The TEPS is an 18 item self-report questionnaire relating to pleasurable activities. The participant was presented with a series of statements and asked to rate from 1 “very false for me” to 6 “very true for me” how applicable that statement is to their experiences. This self-report measure has separate subscales for anticipatory items e.g. “I get so excited the night before a major holiday I can hardly sleep” and consummatory items e.g. “I enjoy the feeling of a good yawn.” This is the only trait measure of anticipatory and consummatory pleasure used in previous studies and is therefore utilised in Chapter 4 to test the anticipatory pleasure deficit hypothesis. The relationship between mood, medication, symptoms, functioning and self-reported anticipatory and consummatory pleasure is also examined in this chapter. Subscales were used to examine potential overlap

between self-report ratings of anticipatory and consummatory pleasure and those given experimentally in the COP task. Moderate correlations were expected at most as this method may be particularly limited in assessing consummatory “in the moment” experience as discussed in Chapter 1 (Page 43). The scale shows good internal consistency: Cronbach’s α = .79, .74 and .71 for total, anticipatory and consummatory scales respectively in the validation study (Gard et al., 2006). The scale also showed good test-retest reliability after 5-7 weeks, with r = .81, .80 and .75 for the total scale, anticipatory subscale and consummatory subscale respectively (Gard et al., 2006). It has been widely used in anhedonia research and is well-validated in control and clinical populations (e.g. Favord et al, 2009).

3.6.3 Questionnaires Measuring Potential Moderating Factors:

3.6.3.1 Personal Details

The personal details questionnaire was administered to obtain demographic information: age, gender, highest education level, employment status and ethnicity. Criteria for psychiatric diagnoses were assessed using the Structured Clinical Interview for DSM-IV (SCID) to review the medical records. Prescription data were collected from medical records to calculate chlorpromazine dosage equivalents (CPZ) for all participants prescribed anti-psychotic medication (Danivas & Venkatasubramanian, 2013; Woods, 2003).

3.6.3.2 Mood (State): Positive and Negative Affect Scale (Tellegen, Watson, & Clark, 1988)

The PANAS (state) is a self-report scale that assesses current mood. Participants were asked to rate how much they feel 20 different emotions “right now” (e.g. guilty, interested, proud) on a scale from 1 (not at all) to 5 (extremely). Scores were added together from 10 items each for positive and negative affect scores e.g. “enthusiastic” would contribute to the positive affect score and “insecure” would contribute to the negative affect score. Internal consistency of the two subscales is high when repeated over time lengths ranging from a “moment” to a year: α = .86-.90 for positive affect and α = .84-.87 for negative affect (Tellegen et al., 1988). Test-retest reliability is good and increases as the

length of time between the two measures are completed: $r=.47-.68$ for positive affect and $r=.39-.71$ for negative affect (Tellegen et al., 1988).

3.6.4 Acceptability of the Experience Sampling Study in Both Groups:

3.6.4.1 Experience Sampling Feasibility Questionnaire

An 11-item feasibility questionnaire was developed based on similar scales used in previous ESM studies (Kimhy et al., 2012). This questionnaire assesses overall feasibility of ESM using three categories of questions: acceptability of the experience, disruption to the participant's typical week and the adequacy of training and support provided. Every item asks participants to rate how strongly they agree with each statement on a 7-point Likert scale. The experience score was the average of three items assessing ease and enjoyment of completing the week as well as any embarrassment experienced e.g. "I enjoyed the experience sampling week". The training and support score was the average of two items e.g. "I felt supported by the research team during the experience sampling week". The disruption score was the average of the remaining five items assessing how typical the week was and whether normal activities were disrupted e.g. "The experience sampling device disrupted my everyday life". This provides a measure of the external validity of the responses given during the week by assessing whether an individual's typical routines were disrupted. An average score of 1-3 was considered negative for each category of items.

3.6.5 Clinical Screening of Control Participants: Mini International Neuropsychiatric Interview (Sheehan et al., 1998)

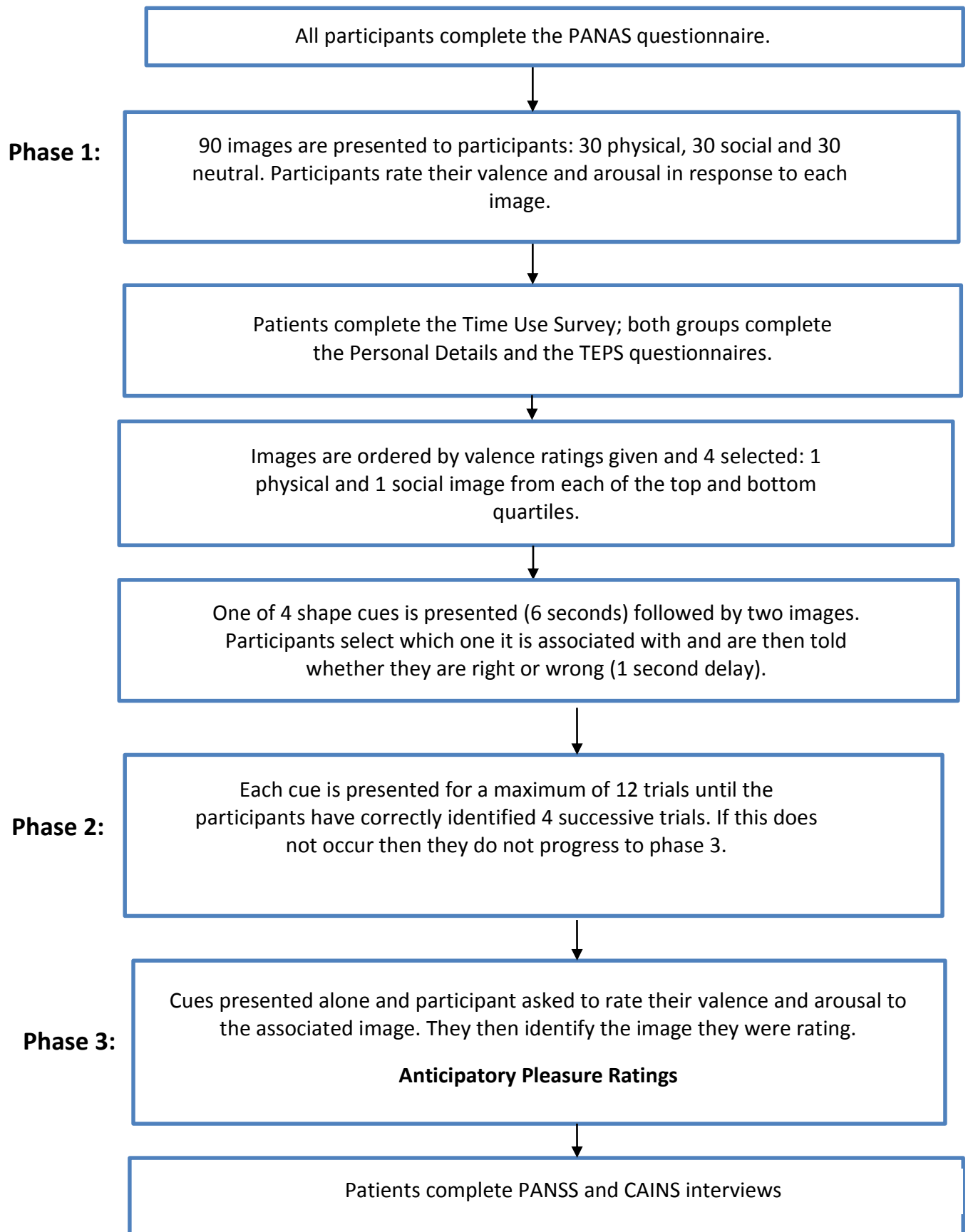
This short interview is based on the Structured Clinical Interview for Mental Disorders according to criteria stipulated in the DSM-IV (First, 2002). The MINI assesses whether an individual is currently likely to meet criteria for mental health problems and/or whether they may have experienced them in the past. Individuals are asked opening questions which enquire about the key symptoms for each of the disorders examined e.g. "Have you felt consistently depressed or down, most of the day, nearly every day, for longer than two weeks?" If the answer to one of these key questions is "yes" then follow-up

questions are asked regarding the severity of the problem. A threshold is set where the individual is considered to have experienced symptoms severe enough to be considered clinically relevant. Individuals who passed this threshold were considered ineligible for the study. This screening tool was chosen due to its comprehensive and thorough structure and because it took on average less than 20mins to conduct so would not extensively inconvenience potential participants. The MINI has been used extensively in schizophrenia research (Arias et al., 2013; Hui et al., 2013; Mosolov, Potapov, Ushakov, Shafarenko, & Kostyukova, 2014).

3.7 Study Procedure

The procedure of the first session of the study is outlined below in Figure 13. Once participants have completed this first session they are invited to repeat the COP task and PANAS questionnaire in a second session within two weeks in order to assess test-retest reliability of the COP task. This time period was selected as it has been used in reliability studies of other measures of the experience of pleasure including the CAINS (Kring et al., 2013). Two weeks was considered long enough to ensure that any memory of ratings given in the first session would be minimised. If a participant successfully completes both anticipatory and consummatory phases of the COP task in the first session they are also invited to take part in the ESM study.

Figure 13: Study protocol: Session 1



3.8 Analysis

3.8.1 Data Quality

All ratings were examined for normality using Shapiro-Wilks tests and visual inspection of Q-Q plots (Ghasemi & Zahediasl, 2012). It was important to combine these methods as the Shapiro-Wilks test alone can produce false positives in larger samples (Royston, 1992). Once normality was confirmed parametric tests were conducted. Variables not normally distributed were logarithmically transformed (Lg10) and normality analyses repeated. If data were still not normally distributed non-parametric tests were conducted on the non-transformed data. Data were examined for outliers that were over ± 2 standard deviations from the mean. Analyses were repeated with these outlying data-points excluded (Tabachnick, 2013). The significance level threshold was set at $p < 0.05$, with trend findings reported at $p < .1$. All tests conducted were 2-tailed (Field, 2009). The Benjamini & Hochberg False Discovery rate was applied to the correlational analyses to control for the multiple tests conducted (Benjamini & Hochberg, 1995). The false discovery rate is applied as a multiplier to the p values for each test based on the total number of tests conducted. This method maximises power of the findings once applied, which gives it an advantage over alternative methods of controlling for multiple correlational analyses (Noble, 2009). The significance threshold remains at $p = 0.05$ and the findings are reported in accordance with this. Analyses were conducted in SPSS (Version 21) (SPSS Inc, 2012) and Stata (Version 11.2) (StataCorp, 2009).

3.8.2 Descriptive Statistics

In all studies the demographics of the participants in both groups were presented. The groups were compared on these variables using chi-squared tests for categorical variables e.g. ethnicity, and t-tests for continuous variables e.g. age. The mean and distribution of the scores on the scales used were also reported.

3.8.3 Chapter 4: Relationships between TEPS Subscales, Mood and Negative Symptoms

A one-way ANOVA was conducted to identify a group effect in anticipatory and consummatory pleasure scores on the TEPS. Pearson's correlational analyses were conducted between the subscales, and - to examine their relationships with the wider context - medication (CPZ equivalent dosages), mood, symptoms and functioning. If any significant relationships with medication and mood were identified, analyses of relationships between TEPS subscales, symptoms and functioning were repeated as partial correlations controlling for mood and/or medication.

3.8.4 Chapter 5: Reliability and Validity of Computer Task

To confirm that images labelled as pleasant were rated as such by the participants they were compared to neutral images using paired t-test analyses within each group. Cronbach's alpha values were calculated to assess internal consistency within each category of images presented in the consummatory phase and anticipatory phase. Mean reaction times in both phases were calculated to ensure that sufficient time was spent viewing each image to provide a valid rating. Incorrect trials were excluded from the analyses of the anticipatory ratings. Test-retest reliability of ratings across the two time points was established with intra-class correlation coefficients. High correlations (above 0.8) are indicative of good test-retest reliability (Field, 2009). Correlations with the TEPS scores were calculated as a measure of convergent validity.

3.8.5 Chapter 6: Anticipatory and Consummatory Pleasure in an Experimental Context: The COP Task

3.8.5.1 ANOVA Analyses

To examine whether there is a specific anticipatory deficit in people with schizophrenia mean anticipatory and consummatory ratings were compared between groups using two one-way ANOVAs. Partial eta squared values are reported for all ANOVA analyses as a measure of the effect size (Tabachnick, 2013). Consummatory ratings were

subtracted from anticipatory ratings of the same stimulus to create anticipatory-consummatory discrepancy scores. The COP task made it possible to examine whether this discrepancy is larger in people with schizophrenia. This was done using one-way ANOVAs to compare anticipatory-consummatory difference scores between groups for overall scores as well as different image types (physical high, physical low, social high, social low).

3.8.5.2 Exploratory Analysis of Potential Moderators

Pearson correlational analyses were conducted to assess whether positive or negative mood were associated with consummatory or anticipatory ratings as has been seen in previous research in controls (Larson et al., 2013). If correlations were significant then affect was controlled for in further analyses. Chlorpromazine equivalent dosage was correlated with these ratings as dopamine abnormalities and cognitive difficulties have both been proposed as factors that may influence pleasure ratings (Cohen et al., 2011). Ratings of participants who were prescribed typical antipsychotics were compared with those prescribed atypical antipsychotics as previous studies suggest that these medications may have differing effects on anticipatory pleasure e.g. Juckel, Schlagenhauf, Koslowski, Filonov, et al. (2006)

3.8.5.3 Associations with Symptoms and Functioning

Symptom and functioning measures (Time Use, CAINS and PANSS) were correlated with anticipatory and consummatory ratings using a Pearson correlational analysis. This also tested the hypothesis proposed in the literature that anticipatory but not consummatory pleasure may underlie high self-reported anhedonia and poor functioning (Kring & Caponigro, 2010).

3.8.6 Chapter 7: Experience Sampling Acceptability and Internal Validity

Mean scores from the experience sampling feedback questionnaire assessing acceptability and internal validity of the ratings are reported and compared between groups with t-test analyses. To assess the feasibility of experience sampling in these populations the

percentage of non-completers and questionnaires completed is reported. The pattern of questionnaire completion is reported across time of day and over the six days to explore possible fatigue effects or times when it is difficult for controls or people with schizophrenia to complete questionnaires. Frequency of questionnaires completed on each day and time-point are compared within-groups using paired t-tests to identify those where it is significantly reduced. Completion rates are correlated with medication dosage and symptoms to assess whether these factors influence adherence in the group of people with schizophrenia. Chlorpromazine dosage and medication levels will also be compared between high and low completers (defined using a median split).

3.8.7 Chapter 8: Anticipatory and Consummatory Pleasure in Everyday Life: Experience Sampling Study: Multi-Level Modelling

Experience sampling produces a unique data set with numerous observations from the same individuals. There is variation from multiple sources in this data: between individuals, days and beeps/time-points. Thus, the most appropriate data analysis method to use is multi-level linear modelling. This maintains the complexity of the data and maximises the robustness of the analyses as it avoids reducing several data points which vary over time to mean values (Kimhy et al., 2012; Palmier-Claus et al., 2011).

Multi-level models are regression models which take into account two levels of variation in data. These models allow each individual to have differing slopes (α) and intercepts (β) as part of the regression equation. Multi-level modelling has the advantage of providing an evaluation of within-subjects and between-subjects effects and is robust to repeated measures which are key to answering research questions in experience sampling methodology.

Multi-level mixed effects regression models were calculated to address both between-group and within-group research questions. These models are more appropriate for use with experience sampling data than linear/logistic regression models as there are multiple repeated measurements on each day and from each participant in the dataset which results in high levels of covariance. Both random and fixed effects were entered into each model. Random effects are those which are the result of factors that may contribute to

clustering of the data i.e. participant, day and beep and therefore need to be controlled for. Fixed effects result from the variables being examined in the model - the effect of independent variables on the dependent variable. Data were analysed using the **XTMIXED** module which was developed in Stata for multi-level regression models with continuous dependent variables (e.g. pleasure and motivation ratings) (Hartley, Haddock, Vasconcelos, Emsley, & Barrowclough, 2015; Oorschot et al., 2013). The **XTMELOGIT** module was developed for multi-level regression models with categorical dependent variables and was used for analyses in this chapter (e.g. activity levels) (Janssens et al., 2012). Effects from predictors in the multi-level models were expressed as β , representing the fixed regression coefficient.

Variance partition coefficients were used to examine the amount of variance in an independent variable which can be attributed to each random effect entered into a multi-level model (Goldstein, Browne, & Rasbash, 2002). In this case, the random effects in the model were participant, day and beep. This allowed research questions concerning how much items included in the experience sampling questionnaire vary between individuals and over time to be addressed in this chapter. Time-lagged variables (anticipatory pleasure, consummatory pleasure, motivation) were used to predict activity occurring at the next beep (Hartley, Haddock, Vasconcelos, Emsley, & Barrowclough, 2014). In order to perform these analyses the ratings at one time-point were entered as predictors in the model (e.g. mood, pleasure, motivation) and activity at the following time-point was entered as the dependent variable. This allowed fixed effects of these predictors on the outcome (activity at the next beep) to be calculated.

Mean values were calculated for each experience sampling variable across the week for correlational analyses in this chapter and Chapter 9. It is not possible to retain the multi-level form of ESM data and perform correlational analyses. These were the most appropriate analyses to perform with self-report measures which do not have the same multi-level structure as each participant only completes them once. It is therefore not valid to enter them into multi-level regression models with ESM data in their original form as this would violate the assumption of this model that all variables are repeated measures. Pearson correlational analyses were conducted between ESM ratings of anticipatory and

consummatory pleasure and negative symptoms measures to test the TEP model hypotheses that anticipatory but not consummatory pleasure underlies negative symptoms.

3.8.8 Chapter 9: Combined TEPS, Experience Sampling Study and COP Task Analysis

TEPS and COP Task anticipatory and consummatory ratings were correlated with the same ratings in the experience sampling week to assess their degree of convergence. This analysis also provided a degree of external validity of the TEPS ratings and COP task if they correlated with everyday life experience. Partial correlations controlling for mood were conducted to identify whether this was acting as a moderator in any associations.

Chapter 4: The Temporal Experience of Pleasure Scale: Self-Reported Anticipatory and Consummatory Pleasure in the Wider Context of Mood, Symptoms and Functioning

4.1 Introduction

4.1.1 Relationship between TEPS Subscales and Mood

The Temporal Experience of Pleasure Scale (TEPS) was developed as a self-report measure of anticipatory and consummatory pleasure, based on the descriptions from the TEP model (see Chapter 1). The majority of studies that have used this scale have reported an anticipatory pleasure deficit and intact consummatory pleasure in people with schizophrenia (Li et al., 2015). However, one study found the opposite pattern of reduced consummatory pleasure in people with schizophrenia (G. P. Strauss, Wilbur, et al., 2011) and another reports intact anticipatory *and* consummatory pleasure in people with schizophrenia compared to controls (Schlosser et al., 2014). Researchers have suggested that these mixed findings may be due to the increased susceptibility of anticipatory pleasure to the effects of the individual's current context and mood in particular, compared to consummatory pleasure. The influence of context or "state" variables on anticipation is well replicated in studies that examined these processes in controls (Wilson & Gilbert, 2005). However, this has not been examined thoroughly in people with schizophrenia, only one recent study included measures of both current positive affect and the TEPS (Geaney, Treadway, & Smillie, 2015). This study reported that the TEPS anticipatory subscale scores were correlated with positive affect during a positive mood induction paradigm, but the consummatory subscale scores were not (Geaney et al., 2015). This study did not assess negative affect so it is not clear if there is an association between anticipatory or consummatory pleasure and negative emotions such as guilt, fear, anger or sadness. The findings regarding positive affect support the hypothesis of the previous authors (G. P. Strauss, Wilbur, et al., 2011) and the findings from the studies including controls, which report that anticipatory pleasure is associated with current mood. However, this study did not include a control group so it is unclear whether this relationship between anticipatory

pleasure and positive mood is normative. It is also difficult to draw conclusions from a single study and the current work therefore attempted to provide a replication of this finding as well as extending it to a control population and adding a measure of negative affect.

4.1.2 Relationship between TEPS Subscales and Medication

As well as mood there is some evidence from neuroimaging studies that antipsychotic medication dampens activity in the prefrontal cortex when anticipating pleasure (Juckel, Schlagenhauf, Koslowski, Filonov, et al., 2006). There has been a dearth of research investigating a potential link between medication and anticipatory pleasure using the TEPS; although one study reported that controlling for medication in analyses had no impact on the findings (Favrod, Ernst, Giuliani, & Bonsack, 2009). This study only included 21 people with a diagnosis of schizophrenia with a narrow range of chlorpromazine equivalent dosage levels (standard deviation: 259mg) which may contribute to this null finding. No study has directly assessed the relationship between self-reported anticipatory pleasure on the TEPS and medication. The current study tested this relationship in a larger sample with a wider range of chlorpromazine equivalent dosage levels (SD= 438mg) to overcome the limitations of this previous study.

4.1.3 Relationship between TEPS Subscales and Symptom Levels

The relationships between self-reported anticipatory and consummatory pleasure and symptom and functioning measures have been more widely investigated. This is perhaps due to the hypothesis in the TEP model that anticipatory and not consummatory pleasure underlies high levels of self-reported anhedonia and poor functioning in people with schizophrenia (Kring & Caponigro, 2010). The findings, however, have provided only limited support for this hypothesis. Three studies found that both the anticipatory and consummatory TEPS subscales correlated with negative symptom scales from the PANSS and BPRS (Chan et al., 2012; Li et al., 2015; Mote et al., 2014). These studies had large samples but one of the two conducted by the Beijing research group did not compare TEPS scores between people with schizophrenia and controls (Li et al., 2015) and the other reported no difference between these groups in either TEPS subscale (Chan et al., 2012). As

the central hypothesis from the TEP model assumes reduced anticipatory pleasure in people with schizophrenia compared to controls the lack of this deficit in these studies is problematic for the interpretation of the findings. The smallest study (n=88) (Mote et al., 2014) did report reduced TEPS anticipatory pleasure in people with schizophrenia. This difference between the studies may be an artefact of the first two studies taking place in a non-Western culture and there may also be some overlap in the characteristics of the samples as both studies were conducted by the same research group.

One study also found that the anticipatory subscale and total TEPS score correlated with SANS anhedonia and avolition (Favrod et al., 2009). However, another study reported no correlation with negative symptoms (G. P. Strauss, Wilbur, et al., 2011). All of the studies discussed in this chapter included stable, community samples of people with schizophrenia. However, the study by G. P. Strauss, Wilbur, et al. (2011) includes a low percentage (12%) of people prescribed typical antipsychotic medication compared to other studies examining the TEPS (30+%) e.g. (Chan et al., 2012). As discussed previously the impact of antipsychotic medication on anticipatory pleasure is still unclear but one previous study found that typical antipsychotic medications have a larger negative effect on anticipatory pleasure than atypical antipsychotic medications (Juckel, Schlagenhauf, Koslowski, Filonov, et al., 2006). This may explain the null finding in this study but it also further highlights the need to examine the role of medication in anticipatory pleasure.

Overall the findings suggest that the TEPS is measuring constructs which underlie the high levels of negative symptoms reported but this is not specific to the anticipatory pleasure subscale. Symptoms could also be interpreted as part of the wider context of the individual and it seems these experiences may be related to both anticipatory and consummatory pleasure. This study attempted to add to the consensus in this area using the PANSS and extend the field by assessing the relationship between the TEPS and the CAINS which is a newer, more specific measure of negative symptoms. The mixed findings in the literature may be due to the low specificity of the PANSS, BPRS and SANS for motivation and anhedonia. Replication of these findings with the CAINS could therefore strengthen the conclusions drawn from the field.

4.1.4 Relationship between TEPS Subscales and Functioning

The TEP model also proposes that an anticipatory pleasure deficit contributes to poor functioning in people with schizophrenia as it leads to low motivation and reduced activity levels. This hypothesis has only been tested once in the literature using the TEPS and the authors reported no associations between anticipatory or consummatory pleasure and social or occupational functioning (Mote et al., 2014). However, the sample included in this study had a mean age of 20 and were therefore younger and had a shorter duration of illness than the participants included in most studies examining negative symptoms. The length of illness is important as functioning declines over time in people with schizophrenia (Cichocki et al., 2015; Menendez-Miranda et al., 2015). This study used the Time Use Survey, as it is a thorough measure of everyday functioning, in a chronic sample with a longer duration of illness to conduct a re-examination of this hypothesis.

4.1.5 Mood and Medication as Potential Moderators

Those individuals with more severe symptoms are also likely to be prescribed higher levels of antipsychotic medication. Furthermore, several experience sampling studies have shown that “state” mood is associated with an increased frequency of symptoms and the distress associated with them in everyday life (Oorschot et al., 2012; Thewissen et al., 2011; van Os, Lataster, Delespaul, Wichers, & Myin-Germeys, 2014). There is also evidence that depressed mood predicts worse functioning in people with schizophrenia (Bowie, Depp, et al., 2010) and happiness levels are positively associated with higher social and occupational functioning in this disorder (Agid et al., 2012). However, both these studies used self-report measures rather than experience sampling and therefore these findings may not reflect “state” mood. As mood states are associated with functioning, medication, and symptoms they may act as moderators in the relationships between these factors and anticipatory pleasure. This has yet to be examined in the literature and was a central aim of this study.

4.1.6 Aims and Hypotheses

This study aimed to assess whether self-reported anticipatory pleasure and consummatory pleasure are associated with current mood or medication. The second aim was to examine the relationships between the TEPS and negative symptoms (PANSS and CAINS) and functioning (Time Use Survey). Finally, if these relationships were found to be present, the roles of medication and mood as moderators were examined.

The hypotheses were as follows:

- (i) Anticipatory pleasure is reduced in people with schizophrenia compared to controls; there is no difference in consummatory pleasure.
- (ii) Anticipatory and consummatory pleasure are positively associated with current positive mood and negatively associated with current negative mood; chlorpromazine equivalent dosages are negatively associated with anticipatory pleasure.
- (iii) Anticipatory pleasure, not consummatory pleasure is associated with the CAINS experiential subscale, both will correlate with the PANSS negative symptom subscale due to its lower specificity for anticipatory pleasure.
- (iv) Anticipatory pleasure is positively associated with functioning scores on the Time Use Survey.

4.2 Method

4.2.1 Sample

The recruitment procedure and inclusion/exclusion criteria for the controls and individuals with schizophrenia are detailed in Chapter 3 (Pages 109-110).

4.2.2 Measures

The following measures were included in the study, full details of each one is given in Chapter 3 (Pages 113-117).

- Mini International Neuropsychiatric Interview
- Positive and Negative Syndrome Scale (PANSS)
- Clinical Assessment Interview for Negative Symptoms (CAINS)
- Time Use Survey
- TEPS
- Positive And Negative Affect Scale
- Demographics Questionnaire

4.2.3 Procedure

All the measures were completed in one session, with the exception of the MINI which was used as a telephone screening measure in the control group. The participants all completed the PANAS at the start of the session. The Time Use Survey and TEPS were completed in a break from the computer task mid-way through the session. Finally, the clinical assessments (CAINS and PANSS) were completed by the participants with a diagnosis of schizophrenia, with the researcher, at the end of the session (see Chapter 3, Page 119).

4.2.4 Analyses

All the data were examined to ensure the assumptions of normality were met as described in Chapter 3 (Page 120). Between-group differences in the TEPS anticipatory and consummatory subscale scores were examined using one-way ANOVAs. Pearson's correlational analyses were conducted, if normality assumptions were met, to assess the relationships between TEPS subscales and mood, medication, negative symptoms and functioning. To assess whether mood or medication are acting as moderators these variables were controlled for in partial correlations of the relationships between symptoms, functioning and the TEPS subscales.

4.3 Results

The samples were matched for age and gender (see Table 11). Positive affect was similar between groups but negative affect was significantly higher in the schizophrenia group.

Table 11: Characteristics of the full sample

	HC (n=52)	SZ (n=53)	Test (X ² or t-test)
Mean Age(SD)	40.33 (11.25)	42.66 (9.00)	t = -1.29, p=.20
% Female	37%	26%	X ² =1.25 p=.30
% Ethnicity	54% White; 35% Black; 11% Asian.	34% White; 62% Black; 4% Asian.	X ² =8.6, p=.01
% Highest Level of Education Achieved	65% HE 25% FE 10% SS.	13% HE 40% FE 47% SS	X ² = 32.99, p<.0001
PANAS Positive Mean (SD)	30.29 (7.51)	30.08 (8.60)	t=.14, p=.89
PANAS Negative Mean (SD)	10.96 (1.92)	17.55 (7.2)	t=-6.32, p<.0001
PANSS Negative Mean (SD)	N/A	17.54 (4.13)	
PANSS Depressed Mean (SD)	N/A	6.58 (2.75)	
PANSS Disorganised Mean (SD)	N/A	6.44 (2.35)	
PANSS Excited Mean (SD)	N/A	5.12 (1.42)	
PANSS Positive Mean (SD)	N/A	9.19 (4.70)	
CAINS Experiential Mean (SD)	N/A	20.87 (4.75)	
CAINS Expressive Mean (SD)	N/A	6.40 (3.60)	
Time Use Survey CEA Mean (SD)	N/A	18.46 (16.02)	
Time Use Survey SA Mean (SD)	N/A	32.51 (23.14)	
Chlorpormazine Equivalent Dosage (mg) Mean (SD)	N/A	462.53 (438.69)	

SS= secondary school (<=16yrs), FE = further education (16-18yrs), HE = higher education (18yrs+)

4.3.1 Between-Group Differences in the TEPS Subscales

The TEPS scores in both groups are presented in Table 12 below. The schizophrenia group have a reduced consummatory subscale score and trend lower anticipatory subscale score compared to the control group. The anticipatory and consummatory subscales correlate moderately with each other in both the control ($r=.40$, $p=.004$) and schizophrenia ($r=.46$, $p=.001$) groups.

Table 12: TEPS self-report measure in both groups

	Control Group (n=51)	Schizophrenia Group (n=54)	Comparison (One- Way ANOVA)
TEPS Anticipatory Subscale Total	45.31 (6.55)	42.57 (8.16)	F(103)=3.58, $p=.06$
Mean (SD)			
TEPS Consummatory Subscale Total	37 (6.61)	32.74 (8.37)	F(103)=8.31, $p=.01$
Mean (SD)			

4.3.2 Associations between TEPS Subscales and “State” Positive and Negative Affect (PANAS)

Only one relationship was significant in these analyses (see Table 13), positive affect strongly correlated with TEPS anticipatory pleasure in the schizophrenia group. Chlorpromazine equivalent dosages did not correlate with either consummatory ($r=.20$, $p=.17$) or anticipatory ($r=-.03$, $p=.84$) pleasure.

Table 13: Correlation matrix between TEPS subscales and positive and negative affect scale (PANAS)

	HC (n=51)		SZ (n=54)	
	TEPS Ant	TEPS Con	TEPS Ant	TEPS Con
PANAS PA	.11	.20	.52*	.22
PANAS NA	-.18	-.11	-.08	-.12

*=p<.05

4.3.3 Are the TEPS Subscales Associated with Negative Symptom Measures?

The TEPS subscales did not correlate with measures of negative symptoms (see Table 14) except for the TEPS consummatory subscale which *inversely* correlated with CAINS experiential scores in contrast to the hypothesis. The association between TEPS consummatory and CAINS experiential scales was no longer significant when partial correlations were conducted controlling for positive affect ($r = -.23$, $p = .10$), no other findings were altered.

Table 14: Correlation matrix between TEPS subscales and negative symptom measures

	CAINS Experiential (n=53)	CAINS Expressive (n=53)	PANSS Negative (n=53)	PANSS Depressed (n=53)	PANSS Disorganised (n=53)
TEPS Ant	-.21	.01	-.17	-.21	.15
TEPS Con	-.28*	-.07	-.06	-.12	-.09

*=p<.05

4.3.4 Are the TEPS Subscales Associated with Functioning?

In contrast to the hypothesis advanced the anticipatory and consummatory subscales did not correlate with either Time Use CEA (Ant: $r=.03$, $p=.84$; Con: $r= -.04$, $p=.78$) or SA (Ant: $r= -.03$, $p=.84$; Con: $r= -.09$, $p=.51$) scores in the schizophrenia group. These findings were not altered when a partial correlation was conducted controlling for positive affect.

4.4 Discussion

The aim of this study was to assess the relationships between a self-report measure of anticipatory and consummatory pleasure and mood state, symptoms, functioning and medication levels.

The findings replicated a previous study which reported reduced TEPS consummatory pleasure and intact anticipatory pleasure in people with schizophrenia (G. P. Strauss, Wilbur, et al., 2011). This was in contrast to the hypothesis which proposes an anticipatory pleasure deficit in the context of intact consummatory pleasure as has been reported in the majority of studies using the TEPS (Li et al., 2015). However, the field is increasingly producing mixed findings, with another recent study finding no difference between people with schizophrenia and controls in either anticipatory or consummatory pleasure (Schlosser et al., 2014). This study also reported differences in the TEPS scores across the course of the illness with the lowest anticipatory pleasure reported in a clinical high risk group (Schlosser et al., 2014). The TEPS anticipatory (mean=4.11, SD=0.93) and consummatory (mean=4.31, SD=1.1) scores in the chronic sample were very similar to those reported in the current study. The finding of intact anticipatory pleasure in the current study may therefore reflect the chronic sample included.

The association between anticipatory pleasure and positive affect identified in the schizophrenia group replicates the finding from the previous study examining this relationship (Geaney et al., 2015). This suggests that the mixed findings regarding the nature

of anticipatory pleasure in people with schizophrenia compared to controls may be the result of fluctuations in positive affect. The current TEPS literature lacks state measures of affect and this finding suggests the inclusion of a measure such as the PANAS should be a priority in future research using this scale. The absence of a relationship in the control group suggests that people with schizophrenia may be particularly susceptible to concurrent positive affect when anticipating pleasure.

This study failed to replicate the previous finding that TEPS subscales are associated with negative symptom measures such as the PANSS and CAINS. A partial correlation analysis provided very preliminary evidence for a moderating role of positive affect in the relationship between TEPS and symptom measures. The people in the chronic sample recruited in this study were stable in their presentation and all resided in the community. This restricts the range of symptoms recorded in the study and therefore the ability to detect an association and generalise it may be limited in this sample. However, it is important to note that one previous study which also recruited people with chronic schizophrenia found no association with negative symptoms (G. P. Strauss, Wilbur, et al., 2011). The lack of association with functioning scores on the Time Use Survey also replicates a previous finding in the literature (Mote et al., 2014). The participants included in the previous study conducted by Mote et al. (2014) had a shorter duration of illness than those included in the current study suggesting this relationship may be absent across the course of the illness. There are many other potential moderators involved in any analyses focused on functioning levels and the findings must be considered in the context of poverty, lack of opportunity, social cognitive problems and neurocognitive deficits. The individual's activity and symptom levels represent a broad overview of the context in which the individual is rating their anticipatory pleasure. It seems that whilst positive affective states do have a relationship with anticipation in the schizophrenia group, this wider context of symptoms and activity is not related to anticipatory ratings.

4.4.1 Future Utility of the TEPS

The findings from this study offer only limited support for prioritising the TEPS in future research examining anticipatory and consummatory pleasure in schizophrenia. The findings using this measure are not consistent between studies which could reflect

instability in the scale as a result of fluctuations in concurrent positive affect. The influence of mood on the experience of pleasure is unclear and state affect is not included in the TEP model. This study suggests current mood should be measured and perhaps controlled for in studies examining the experience of pleasure. The findings from this study showed only moderate correlations between the anticipatory and consummatory subscales. Support for the distinction between anticipatory and consummatory pleasure is found in the specific relationship between anticipatory pleasure and positive affect in people with schizophrenia.

Chapter 5: Reliability and Validity of the Components of Pleasure Task

5.1 Introduction

The assumption in the TEP model and the wider literature is that the capacity to experience anticipatory pleasure is a trait-like construct (Cohen et al., 2011). Therefore, the hypothesised deficit in anticipatory pleasure in people with schizophrenia is considered to be stable over time. Any paradigm or measure of the experience of pleasure should therefore produce stable ratings over time. This applies to the newly developed COP task paradigm in this study. It is common for test-retest reliability to be reported regarding self-report questionnaires and interviews in this field (Kay et al., 1988; Kring et al., 2013; Mueser, Sayers, Schooler, Mance, & Haas, 1994) and neuroimaging paradigms where the reliability findings are mixed (Bennett & Miller, 2010). It is rare for this information to be reported for experimental paradigms and it is absent from all three previous studies using experimental tasks to assess anticipatory and consummatory pleasure (Choi et al., 2013; Trémeau et al., 2010; Trémeau et al., 2014). Furthermore, the reliability of the multiple experimental paradigms which assess consummatory pleasure in people with schizophrenia is not discussed in either of the meta-analyses in the field (Cohen & Minor, 2010; Yan et al., 2012). Although the majority of studies use IAPS pictures for which some reliability data has been published (Lang et al., 1999a) this is not sufficient to establish the reliability of these stimuli in the context of differing paradigms. The lack of reliability data greatly limits the conclusions that can be drawn regarding the findings from these studies as it is not clear if they are consistently assessing the trait capacity to experience pleasure proposed in the TEP model. The lack of reliability data also limits the development of interventions as trials require outcome measures that conduct assessments of anticipatory and consummatory pleasure which are stable over time. If the currently available paradigms were utilised in clinical trials it would not be clear if any changes seen were due to the intervention or fluctuations due to low reliability of the ratings from the task.

Stimuli presented in the context of these tasks should also show good internal consistency within each category i.e. pleasant or neutral stimuli. The responses to individual

pictures in the same category should not vary substantially if the images have been categorised appropriately. Internal consistency of self-report measures is often reported during the validation and development of a new scale (Chan et al., 2010; C. Forbes et al., 2010; Sheehan et al., 1998). Again, although many studies use the averages from a series of images in the same category (i.e. unpleasant, neutral, and pleasant) in the analyses of consummatory pleasure ratings, there is a lack of reported internal consistency in the categories used (Dowd & Barch, 2010; Herbener et al., 2008; Yan et al., 2012). This makes it difficult to draw conclusions from the analyses conducted and generalise the findings across different studies as it is unclear if all the images labelled as “pleasant” were assessing the constructs consistently. If the images selected had low internal consistency and elicited a wide range of responses this could also inform the development of new paradigms to overcome this limitation. Currently the field is replicating these paradigms without confirmation that the categorisations of stimuli as “pleasant” or “neutral” are valid.

If the COP task is indeed assessing trait characteristics then it should show some degree of association with the TEPS which has been developed as a trait measure of anticipatory and consummatory pleasure. This is currently the only other validated trait measure of anticipatory and consummatory pleasure available, it demonstrates good test-retest reliability and internal consistency as described in Chapter 3 (Page 115) (Gard et al., 2006). However, associations with the COP task are likely to be moderate due to the differing nature of the methodologies; the TEPS is a self-report scale and the COP task is an experimental paradigm. The limitation of the TEPS in assessing consummatory pleasure using hypothetical scenarios (e.g. “the smell of freshly cut grass is enjoyable for me”) may also prevent higher correlations occurring with consummatory ratings of images on the COP task.

The overall aim of this study was to validate the COP task and assess its psychometric properties. Firstly, this study described and compared how long the participants in each group spent rating the images to ensure each image was considered for an adequate time to produce an accurate rating. The numbers of trials completed in the learning phase as well as the number of trials correctly identified in the anticipatory phase are reported to assess learning in both groups. The validation of the image categories was assessed using the internal consistency of the ratings in each group. It was considered

imperative to assess the test-retest reliability of the task to ensure it is producing stable ratings and consistently measuring the same processes. The expectation was that this reliability is high to support the use of the task over time e.g. as an outcome measure. Convergent validity with the TEPS was assessed by measuring the association between the two measures of anticipatory and consummatory pleasure. Due to differences between these methodologies e.g. the use of images compared to hypothetical situations, they were not expected to converge completely but show a moderate degree of association.

5.2 Methodology

5.2.1 Sample

The inclusion/exclusion criteria and recruitment procedure are detailed in Chapter 3 (Pages 108-110).

5.2.2 Measures

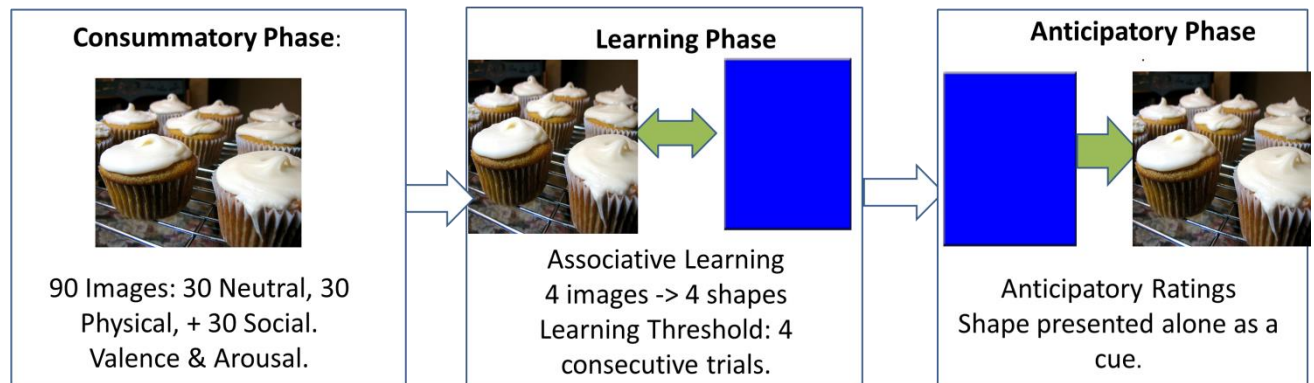
Temporal Experience of Pleasure Scale (TEPS) (Gard et al., 2006)

This was used to assess convergent validity with the anticipatory and consummatory ratings made during the COP task. Examples of the items included in this measure are in Chapter 3.

5.2.3 COP Task

The COP task has three phases; consummatory ratings phase, learning phase and anticipatory ratings phase. The images used in the task are divided into physical, social and neutral categories. A schematic diagram of the task illustrating these phases can be seen in Figure 14, the full protocol of the task is described in Chapter 3 (Page 89).

Figure 14: Schematic diagram of the COP task



5.2.4 Procedure

Eligible participants attended two testing sessions. In the first session during a break between the first and second phases of the computer task the demographic questionnaire and the TEPS were completed. Participants were then invited to repeat the computer task in a second testing session within a time period of 1-2 weeks; the majority (73%) attended at one week. This test-retest time period has been used previously in studies assessing test-retest reliability of negative symptom assessments (Kirkpatrick et al., 2011).

5.2.5 Analyses

5.2.5.1 Data Quality

As described in Chapter 3 (Page 120) the data were examined to ensure they fit the assumptions of parametric tests and outliers (± 2 standard deviations from the mean) were excluded. The significance threshold of the Shapiro-Wilks tests of normality conducted (see Chapter 3, Page 120) was adjusted to $p=.01$ to control for multiple testing.

5.2.5.2 Response Times and Learning Analyses

To ensure adequate time was spent viewing each image to provide a meaningful rating mean response times were reported and compared between groups using t-tests. To characterise the learning that occurred in each group the number of trials needed to pass

the threshold and the percentage of correct trials in each group were reported and compared between groups using t-tests. Trials on which the individual failed to identify the correct image when anticipating were excluded from the analyses of the anticipatory ratings. The number of correct trials was correlated with anticipatory ratings to test whether the level of learning was associated with the ratings given.

5.2.5.3 Image Categorisation and Internal Consistency

To confirm images labelled as pleasant were rated as such in each group, the ratings of the pleasant images were compared to those for the neutral images using paired t-test analyses within each group. Cronbach's alpha values were calculated to assess internal consistency within each category of images presented in the consummatory phase in each group.

5.2.5.4 Test-Retest Reliability and Convergent Validity

The test-retest reliability of the consummatory and anticipatory ratings across the two time points was established with intra-class correlation coefficients. Convergent validity of both the anticipatory and consummatory ratings was explored with the TEPS self-report measure using Pearson correlation analyses.

5.3 Results

Forty-nine individuals with schizophrenia (Table 15) successfully completed both anticipatory and consummatory ratings. Thirty five also repeated the COP task within two weeks (mean=7.11 days, SD=2.34).

Forty-eight control individuals completed both the consummatory and anticipatory phases of the task (Table 15). 43 of these individuals completed the task twice within a two-week period (mean=6.98 days, SD=2.93) for test-retest analyses.

Table 15: COP task sample characteristics

	Completed Consummatory + Anticipatory Phase			Completed Test-Retest Phase		
	HC (n=48)	SZ (n=49)	Test (X ² or t-test)	HC (n=43)	SZ (n=35)	Test (X ² or t-test)
Mean Age(SD)	39.94 (11.16)	42.64 (8.36)	t=-1.36, p=.18	39.42 (11.32)	42.8 (8.85)	t=-1.44, p=.15
% Female	33%	28%	X ² = .33, p=.66.	30%	20%	X ² = 1.06,p=.44
% Ethnicity	52% White; 35% Black; 13% Asian.	32% White; 64% Black; 4% Asian	X ² =8.53, p=.01.	53% White; 35% Black; 12% Asian	40% White; 57% Black; 3% Asian	X ² = 4.8, p=.09
% Highest Level of Education Achieved	67% HE 23% FE 10% SS	14% HE 42% FE 44% SS	X ² =29.83, p<.0001	72% HE 21% FE 7% SS	14% HE 46% FE 40% SS	X ² = 27.32, p<.0001
PANAS Positive Mean (SD)	29.98 (8.03)	29.86 (8.28)	t=.32, p=.75	29.95 (7.38)	30.91 (8.26)	t=-.54, p=.59
PANAS Negative Mean (SD)	13.86 (6.00)	17.78 (7.31)	t= -6.83, p<.0001	10.69 (1.09)	17.03 (6.22)	t=-6.49, p<.0001
PANSS Negative Symptom Subscale Mean (SD)	N/A	17.33 (3.98)		N/A	17.80 (4.15)	
PANSS Depressed Symptom Subscale Mean (SD)	N/A	6.69 (2.73)		N/A	6.77 (2.81)	
PANSS Disorganised Symptom Subscale Mean (SD)	N/A	6.43 (2.34)		N/A	6.37 (1.99)	
PANSS Positive Symptom Subscale Mean (SD)	N/A	9.31 (4.77)		N/A	8.97 (4.58)	
PANSS Excited Symptom Subscale Mean (SD)	N/A	5.08 (1.43)		N/A	4.97 (1.29)	
Chlorpromazine Equivalent mg dosage/day Mean (SD)	N/A	447.62 (410.16)		N/A	408.5 (356.01)	

SS= secondary school (<=16yrs), FE = further education (16-18yrs), HE = higher education (18yrs+)

5.3.1 Data Quality

5.3.1.1 Consummatory Ratings

In the schizophrenia group consummatory ratings were normally distributed according to Shapiro-Wilk analyses ($W(53) = .96-.99$, $p > .01$) with the exception of social valence ($W(53) = .94$, $p = .01$). In the control group the ratings were also normally distributed ($W(52) = .97-.98$, $p = .01$) except for neutral valence ($W(52) = .93$, $p < .01$). Visual inspection of these Q-Q plots revealed no major violations of the normality assumption enabling the use of parametric analyses (see Appendix 11 for Q-Q Plots).

5.3.1.2 Anticipatory Ratings

In the schizophrenia group anticipatory ratings were all normally distributed according to a Shapiro-Wilk test ($W(32) = .93-.98$, $p > .01$) with the exception of social low valence ($W(32) = .90$, $p = .01$). In the control group the normal distributions were confirmed in all categories ($W(35) = .92-.97$, $p > .01$) except for social low valence ($W(35) = .87$, $p = .001$). However, visual inspections of the Q-Q plots revealed no major violations of the normality assumption so parametric tests were used (see Appendix 11 for Q-Q plots). Two outliers were excluded from the anticipatory ratings analyses in the schizophrenia group (± 2 standard deviations from the mean, see Chapter 3, Page 120).

5.3.2 Response Times and Learning Characteristics

It is important when establishing the validity of the findings to demonstrate that each participant took sufficient time viewing the image to provide a meaningful rating. The mean and minimum response times for each group and each category of image are presented in Table 16 below. The people with schizophrenia took significantly longer to complete both consummatory and anticipatory ratings.

Table 16: Response times during COP task

	Control Group	Schizophrenia Group	Comparison (t-test)
Consummatory Rating Response Time(secs) Mean (SD)	8.83 (3.41) Min = 4.49 Max = 17.87 n=52	16.56 (8.41) Min = 5.99 Max = 41.22 n=48	t(103)= -6.18, p<.0001
Anticipatory Rating Response Time (secs) Mean (SD)	8.48 (2.53) Min = 5.23 Max =17.42 n=50	15.41 (7.62) Min = 6 Max =48.43 n=53	t(96)= -6.0, p<.0001

The mean percentage of correct trials in the anticipatory phase in the control group was 79.34% (N=48, SD=25.73) and 66% (N=50, SD=24.96) in the schizophrenia group which was significantly lower ($t(91) = 2.34$, $p < .05$). Individuals with schizophrenia completed an average of 20.66 (SD=5.57) trials to pass the threshold of 4 correct trials per image in the learning phase, the control group completed an average of 20.30 (SD=4.95) which was not significantly different ($t(101) = -.35$, $p > .05$). Incorrect trials were excluded from the analyses of the anticipatory ratings. Pearson's correlation analyses showed that the percentage of correct trials did not correlate with anticipatory ratings in either group (HC $r = -.05$ - $-.19$, $p > .05$; SZ $r = -.03$ - $-.24$, $p > .05$).

5.3.3 Reliability

5.3.3.1 Consummatory Ratings

Paired t-tests comparing neutral and pleasant ratings showed that the valence and arousal ratings for the neutral images as expected were significantly lower than those for the physical and social pleasant image ratings in each group ($t = 4.2$ - 14.54 , $p < .0001$). Cronbach's alpha was calculated within each group for the ratings in each category and ranged from .92 to .98 for valence and .95 to .98 for arousal. Intra-class correlation coefficients for both valence and arousal values for each category across the two time-points were all significant for both groups (Control ICC(2, 1) = .69-.90, $p < .001$; SZ ICC(2, 1) = .75-.91, $p < .001$).

5.3.3.2 Anticipatory Ratings

The test-retest reliability of the anticipatory ratings on the correct trials was assessed. Two outliers in the valence ratings were excluded in the schizophrenia group (SZ n=33) and then all the intra-class correlation coefficients for valence and arousal ratings were significant across time points (ICC(2,1)=.42-.79, $p<.02$) except for physical low valence which was significant at trend level (ICC(2,1)= .32, $p=.06$). Intra-class correlation coefficients for each image category in the control group at the two time points were significant for valence (ICC(2, 1) = .60-.70, $p<.001$) and arousal (ICC(2, 1) = .67-.80, $p<.001$).

5.3.4 Convergent Validity

As a result of the finding that both scores were significantly reduced in schizophrenia (see Chapter 4, Page 133) TEPS scores from the control group only were entered into the convergent validity analyses. If people with schizophrenia do have a deficit in these areas as assessed by the TEPS then their ratings cannot be included in the validation analyses as this may introduce bias.

The Pearson correlational analysis of the anticipatory and consummatory ratings from the COP task and the anticipatory and consummatory pleasure subscales from the TEPS is presented in Table 17 below. In the control group the consummatory and anticipatory ratings from the TEPS were associated with the expected subscales in the COP task although with only one category each.

Table 17: A correlation matrix of COP task and self-reported anticipatory and consummatory ratings in the control group

	COP Task Consummatory Ratings			COP Task Anticipatory Ratings	
	Neutral Valence	Social Valence	Physical Valence	High Valence	Low Valence
TEPS Consummatory	.18	.16	.29*	.19	.25
TEPS Anticipatory	.00	.13	.16	.14	.30*

*= $p<.05$.

This pattern was replicated in the schizophrenia group and TEPS anticipatory subscale scores correlated significantly with all three consummatory ratings ($r=.30-.34$, $p<.05$). However, TEPS consummatory subscale scores also correlated with COP task consummatory ratings for neutral and social images ($r=.33-.35$, $p<.05$). The TEPS subscales did not correlate with COP task anticipatory ratings in this group ($r= -.01-.15$, $p>.29$).

5.4 Discussion

The participants spent adequate time considering each image to provide a meaningful rating which can therefore be considered valid. The variability of reaction times was larger in the schizophrenia group but a minimum of 6 seconds suggests that no ratings were made in this group without consideration. The time taken was longer in the schizophrenia group but this replicates a common finding of slowed reaction times in people with schizophrenia across many tasks (Morrens, Hulstijn, & Sabbe, 2007). During the learning phase people in the control group and individuals with schizophrenia took a similar amount of time to pass the learning threshold. This suggests the task has minimised the cognitive load successfully and the well-documented cognitive deficits in schizophrenia (Reichenberg, 2010) have been successfully controlled for in this paradigm. Although the threshold was passed after a similar amount of time in both groups, the number of trials then identified correctly in the anticipatory phase was lower in the schizophrenia group. This was controlled for by excluding incorrect trials from anticipatory analyses. The number of correct trials was not associated with any of the anticipatory ratings suggesting any impact of learning on anticipatory ratings was minimised. The analyses show the categorisation of images used in the task was accurate as “pleasant” images were rated as significantly more pleasant by the participants compared to neutral images. This method of image categorisation validation has been used in previous research (Herbener et al., 2008). The images also showed good internal consistency within each category. Test-retest analyses confirmed that the ratings given for each category were stable across time in both groups and suggest this task assesses a “trait” rather than “state” construct. The task can be considered a reliable and internally valid measure of the components of pleasure proposed in the TEP model.

Correlations were seen between anticipatory and consummatory ratings in the COP task and TEPS although the highest Pearson's r value was only 0.30. These associations were also only present in two of the categories of images in the COP task (physical and low valence) which suggests the TEPS is not as comprehensive an assessment of different types of pleasure and may need to include more social and highly pleasant stimuli. Although both types of measurement assess similar constructs it appears the COP task and the TEPS diverge to some extent. This is unsurprising due to the many differences between the two methodologies in particular the use of hypothetical scenarios in the TEPS and actual image stimuli in the COP task. In the future, researchers may wish to consider these differences as well as the more comprehensive range of stimuli included in the COP task when deciding which measure may be more appropriate for use in their study. In particular the COP task seems to assess social pleasure and reliably elicit highly pleasant responses which are lacking from the TEPS.

The results of the study suggest that the COP task is a reliable and valid measure of anticipatory and consummatory pleasure assessed using the same stimuli for the first time. The established high reliability and internal consistency of this task gives it an advantage over other paradigms previously used in the field which have not reported these data (Herbener et al., 2008; Trémeau et al., 2014; Yan et al., 2012). However, replication of these findings in people with schizophrenia experiencing a broader range of positive symptoms, negative symptoms and disorganisation is important to recommend its use in the wider population of people with schizophrenia. The assumptions in the literature are that anticipatory pleasure is stable over time and that IAPS images consistently reproduce similar consummatory pleasure ratings (Blanchard et al., 2001; Cohen et al., 2011). This is the first experimental paradigm to confirm its assessment of anticipatory and consummatory pleasure is stable over time, supporting these assumptions. This study therefore offers preliminary support for the reliability of the COP task in people with schizophrenia and controls to evaluate the TEP model. It also provides further evidence for the use of IAPS images (Lang, Bradley, & Cuthbert, 2008) in future studies assessing anticipatory and consummatory pleasure. The high test-retest reliability of the COP task supports its repeated use over time, perhaps as an outcome measure in trials of interventions targeting improvements in anticipatory or consummatory pleasure.

Chapter 6: The COP Task: The Discrepancy between Anticipatory and Consummatory Pleasure in Individuals with Schizophrenia and a Control Group

6.1 Introduction

The confirmation of the reliability and internal consistency of the COP task in Chapter 5 supports its use as a measure to examine anticipatory and consummatory pleasure. The TEP model proposes an anticipatory pleasure deficit which contributes to reduced functioning in everyday life. The overall aim of the development of the COP task was to test this hypothesis in people with schizophrenia and controls. However, it is important to firstly consider the findings from the control literature which contains extensive research in this field and therefore contributes to the selection of appropriate hypotheses. The integration of findings from this field into negative symptom research is currently lacking, but may add clarity to the mixed findings presented in Chapter 2 by providing an understanding of adaptive processes when predicting pleasure. These findings from the control literature also guided the expectations from the COP task.

Studies conducted in the general population suggest that predictions of future emotions are usually far from accurate (Gilbert & Wilson, 2007). Humans rely heavily on biases and heuristics for pleasure forecasting. These cause individuals to both under- and over-estimate how much they are going to enjoy different activities depending on their best, worst and most recent experiences and their current context e.g. mood, weather, health, energy (Gilbert & Wilson, 2007). Therefore, there is a consistent discrepancy between the amount of pleasure expected from an event and what the individual experiences during the event itself. These inaccurate predictions may seem illogical but serve several purposes. Anticipating pleasure generates feelings of well-being and has a positive effect on quality of life (Gilbert & Abdullah, 2002). The expectation of pleasure, even if above what can be actually be experienced, maximises the chances of an individual engaging in leisure activities which will also contribute to well-being and quality of life (Iwasaki, Coyle, & Shank, 2010; Jones, Kimberlee, Deave, & Evans, 2013). An over-estimation of pleasure may also encourage engagement in more functional/less pleasant activities e.g.

chores, work, exercise. On the other hand an under-estimation of pleasure may offer protection from future disappointment (Nawijn et al., 2010). Studies examining anticipatory pleasure in controls have used autobiographical scenarios such as birthday parties or a Monday morning at work (Robinson & Clore, 2002; Wilson & Gilbert, 2005). The pleasure associated with these is influenced by external factors such as stressful life events or current employment status, so are difficult to compare across the general population and likely to differ in people with schizophrenia. What is clear from this research is the importance of the nature of the event or stimulus being anticipated; anticipatory ratings disconnected from the experience itself would be difficult to interpret as an over- or under-estimation. This is an issue of relativity; the anticipatory ratings need to be considered *relative* to the consummatory experience to fully understand the anticipatory process occurring. It is important that over-anticipation in particular occurs selectively and in relation to the specific event occurring as otherwise decisions may be guided poorly by this anticipatory process and the individual's resources could be wasted.

The role of biases in anticipatory pleasure in everyday life in individuals with schizophrenia is unclear. Findings from recent studies that examine decision-making in gambling tasks suggest individuals with schizophrenia are less influenced by the confirmation bias and the 'framing effect' bias (which usually result in loss aversion behaviours) than controls (J. K. Brown et al., 2013; Doll et al., 2014). However, these studies did not report the forecasted pleasure that accompanied this behaviour. Studies measuring anticipatory and consummatory pleasure in individuals with schizophrenia and controls did not rely on the participant's experiences or context to generate anticipatory ratings and instead provide them with previews (Choi et al., 2013; Trémeau et al., 2010; Trémeau et al., 2014). Whilst previews reduce the influence of context, they may alter the usual anticipatory process limiting the conclusions that can be drawn concerning the differences between groups. It is unclear from the research conducted whether a reduced influence of biases in schizophrenia impacts on pleasure forecasting and if so whether the accuracy of predictions is increased in schizophrenia as is reported for decision-making in the gambling tasks.

The Components of Pleasure (COP) task overcomes the limitations of previous studies by examining the discrepancy between anticipatory and consummatory pleasure

rather than the average values for each, and thus minimised the influence of context and relativity. The COP task used a learning phase to enable the presentation of a cue to prompt anticipatory ratings of an image the participant had previously seen rather than a novel stimulus. This more closely mimics everyday life, where an individuals' prior experience of pleasure during an event and the associative learning which occurs is incorporated into their expectations. This task used images to measure both components of pleasure, in an experimental context, for the first time. The images were also tailored to the participants' preferences and thus eliminated these idiosyncrasies as a potential source of bias during the selection of images for the anticipatory phase. The selection of images at the top and bottom of each individual's ratings also allowed an examination of how a discrepancy between anticipatory and consummatory pleasure varies with the pleasantness of the stimuli. By measuring anticipatory and consummatory pleasure separately in this task their relationships with other symptoms, mood and functioning could be assessed. The established reliability and validity of this task and the multiple stimuli used for the anticipatory ratings supports the utility of this task to advance the assessment of these pleasure components.

The hypotheses for this study were as follows:

- (i) In line with the hypotheses in the TEP model; ratings of consummatory pleasure are similar in the schizophrenia group compared to controls (Cohen & Minor, 2010).
- (ii) Anticipatory pleasure ratings are reduced in the schizophrenia group compared to controls and there is a larger reduction for social stimuli (Cohen et al., 2011; Tso et al., 2014). These ratings correlate with functioning and negative symptoms in accordance with hypotheses from the TEP model (Kring & Caponigro, 2010).
- (iii) There is a larger discrepancy between the consummatory and anticipatory ratings in the schizophrenia group compared to controls.
- (iv) Current mood correlates with anticipatory and consummatory ratings as seen in previous studies (Larson et al., 2013; Wilson & Gilbert, 2005).

6.2 Method

6.2.1 Sample

The recruitment and inclusion/exclusion criteria for the sample are detailed in Chapter 3 (Pages 108-110).

6.2.2 Measures

The measures included in this chapter are listed below. Please see Chapter 3 (Pages 113-117) for full details of these measures.

- Positive and Negative Affect Scale (Tellegen et al., 1988)
- Positive and Negative Syndrome Scale (Kay et al., 1988).
- Clinical Assessment Interview for Negative Symptoms (C. Forbes et al., 2010)
- Time Use Survey (Fowler et al., 2009)

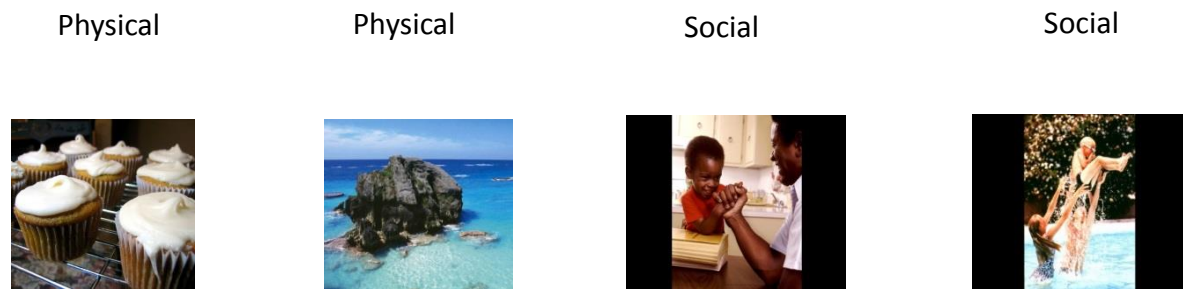
6.2.3 Procedure

The procedure followed is detailed in Chapter 3, Figure 13, page 119 which presents the protocol for this session.

6.2.4 COP Task

The COP task has three phases: consummatory ratings phase, learning phase and anticipatory ratings phase. The images used in the task are divided into physical, social and neutral categories. Four images are selected from the consummatory phase for use in the learning and anticipatory phases. Two are taken from the top and two from the bottom quartile of the physical and social categories using the ratings provided by that individual (see Figure 15). This tailors the images used to each participant's preferences. A schematic diagram of the task can be seen in Chapter 5, Figure 14; the full protocol of the task is described in Chapter 3.

Figure 15: Example of four images selected for learning and anticipatory phases



Ratings used in the analyses are divided into categories according to the image presented to the participant; these are presented Table 18 below.

Table 18: Categories of ratings entered into analyses

Consummatory	Anticipatory
Neutral Valence	
Neutral Arousal	
Physical Valence	Physical High Valence
Physical Arousal	Physical High Arousal
	Physical Low Valence
	Physical Low Arousal
Social Valence	Social High Valence
Social Arousal	Social High Arousal
	Social Low Valence
	Social Low Arousal

6.2.5 Analyses

The demographics of the two groups were compared with t-test and chi-squared analyses. Medication in the form of chlorpromazine equivalents (Woods, 2003) was correlated with consummatory and anticipatory ratings. The anticipatory and consummatory pleasure ratings of individuals with schizophrenia prescribed atypical (loose-binding) anti-psychotic medication were compared with those prescribed typical (tight-binding) anti-psychotic medication to test the hypothesis that typical anti-psychotics have a more significant effect on pleasure (Juckel, Schlagenhauf, Koslowski, Filonov, et al., 2006; Lataster et al., 2011). If medication correlated with ratings it was controlled for in all further analyses.

6.2.5.1 Influence of Context

Correlational analyses were conducted to assess whether mood has an influence on consummatory or anticipatory ratings and therefore should be controlled for in future analyses (Larson et al., 2013).

6.2.5.2 Between-Group Differences in Anticipatory and Consummatory Pleasure

To calculate the anticipatory-consummatory discrepancy scores, the consummatory ratings for the images in each of the anticipatory categories (physical high, physical low, social high and social low) were subtracted from the anticipatory ratings for the same image. An overall discrepancy score was also calculated by summing these discrepancy scores across all the categories. The anticipatory and consummatory ratings and anticipatory-consummatory discrepancy scores were compared between groups using one-way ANOVAs.

6.2.5.3 Relationship with Symptoms and Functioning

Pearson correlational analyses were conducted between consummatory and anticipatory pleasure ratings, symptom measures and the Time Use Survey. This tested the

hypothesis from the TEP model that reduced anticipatory pleasure not consummatory pleasure is associated with functioning and negative symptoms. The Benjamini & Hochberg False Discovery Rate (FDR) (Benjamini & Hochberg, 1995) was applied to these analyses to correct for multiple correlations (see Chapter 3, Page 120). Due to the number of tests conducted only results below the $p < .05$ threshold once this FDR had been applied were reported.

6.3 Results

The demographics of the sample are described in Chapters 4 and 5 (see Tables 11 and 15). Fifty-three individuals with a diagnosis of schizophrenia took part in the study and 52 controls. Two people in the schizophrenia group were not currently prescribed antipsychotic medication. Of the 51 people who were prescribed antipsychotic medication, 44 were currently taking atypical (loose-binding) and 7 were taking typical (tight-binding) antipsychotic medication.

6.3.1 Assessment of Potential Moderators: Mood and Medication

In the control group positive affect as measured by the PANAS positively correlated with consummatory arousal ratings for all three types of image- neutral, social and physical ($r = .46, .37, .48$ respectively, $p < .01$). Positive affect was also associated with anticipatory arousal ratings to both physical and social low pleasantness images ($r = .46, .49$ respectively, $p < .01$).

There was no difference between groups in positive affect ($t(97) = .32, p = .75$) but negative affect was higher in the schizophrenia group ($t(97) = -6.38, p = .0001$), see Chapter 4 (Table 11, Page 132). In the schizophrenia group positive affect correlated with consummatory social valence and arousal ($r = .43, .30$ respectively, $p < .05$) and physical valence ($r = .27, p < .05$). Positive affect only correlated with anticipatory social low valence ratings in this group ($r = .34, p < .05$). Positive affect was controlled for in subsequent analyses due to these findings. Negative affect as measured by the PANAS did not correlate with any consummatory or anticipatory ratings in either group.

Levels of chlorpromazine equivalent dosage (see Chapter 3, Page 116 for calculations) did not correlate with any consummatory ($r = -.03$ – $-.20$, $p > .05$) or anticipatory ($r = .03$ – $-.28$, $p > .05$) ratings from the COP task. There was no significant difference in the consummatory ($F(1,50) = .002$ – $.31$, $p > .05$) or anticipatory ratings ($F(1, 43) = .03$ – 1.52 , $p > .05$) of individuals with schizophrenia prescribed typical compared with those prescribed atypical antipsychotics. As a result of these null findings medication was not entered into further analyses.

6.3.2 Are Pleasure Deficits Related to Negative Symptom and Functioning Scores?

The hypothesised relationship between anticipatory, but not consummatory pleasure and symptoms and functioning was tested (Table 19). The PANSS disorganised subscale had a significant inverse correlation with anticipatory ratings. Conversely, PANSS depressed positively correlated with anticipatory ratings. However, PANSS negative, and both CAINS subscales correlated with consummatory pleasure in contrast to this hypothesis (see Chapter 4, Table 11 for mean values of subscales).

Table 19: Pearson correlation coefficients between symptom measures, functioning, medication and ratings in schizophrenia group; V= valence, A = arousal

Consummatory Ratings							Anticipatory Ratings							
	Neutral		Social		Physical		Physical High		Physical Low		Social High		Social Low	
	V	A	V	A	V	A	V	A	V	A	V	A	V	A
PANSS Negative	0.06	0.05	-0.06	-0.08	-0.14	-0.26*	-0.11	-0.04	-0.01	-0.14	-0.05	0.27	-0.04	0.13
PANSS Disorganised	-0.24	-0.28	-0.25	-0.27	-0.25	-0.26	-0.14	-0.25	-0.35*	-0.22	-0.18	-0.18	-0.10	-0.15
PANSS Depressed	-0.08	0.25	0.14	0.19	0.25	0.22	0.16	0.35*	0.15	0.21	-0.01	0.11	0.32*	0.20
CAINS Expressive	0.22	0.01	-0.02	-0.12	-0.02	-0.29*	-0.16	-0.17	0.10	-0.14	0.02	0.21	0.06	0.06
CAINS Experiential	-0.01	-0.11	-0.22	-0.39*	-0.15	-0.28	-0.07	-0.19	0.15	-0.12	-0.26	-0.24	-0.03	-0.24
Time Use Survey SA	0.26	0.17	0.20	0.19	0.05	0.12	0.06	0.01	0.08	0.09	0.27	0.12	-0.04	0.06

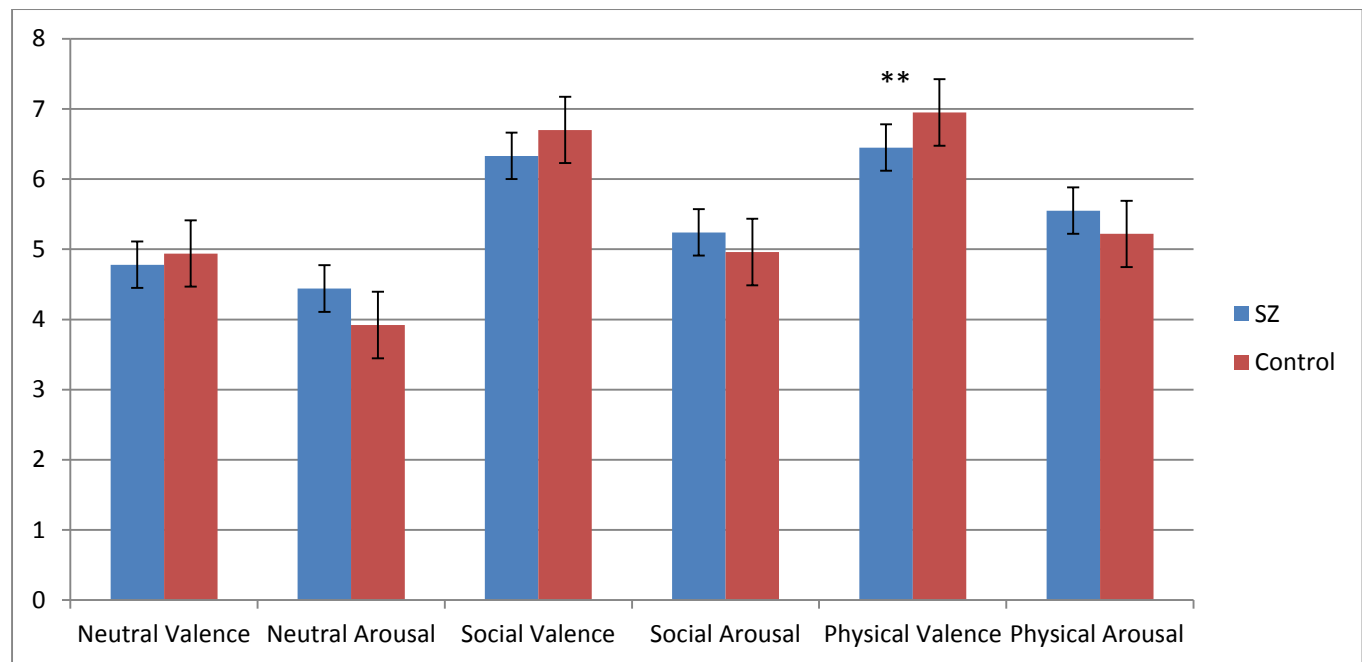
*=p<.05.

6.3.3 Consummatory and Anticipatory Ratings

There was no difference in the consummatory neutral or social pleasant valence ratings between the two groups ($F(1,103) = .59$ ($\eta_p^2=.01$), 2.12 ($\eta_p^2=.02$) respectively; $p>.05$) (see Figure 16). The physical pleasant valence ratings were significantly lower in the SZ group ($F(1,103) = 4.85$, $\eta_p^2=.05$, $p<.05$). As expected, there were no significant differences for consummatory arousal ratings in neutral, social or physical categories controlling for positive affect ($F(1,102) = 3.68$ ($\eta_p^2=.04$), $.84$ ($\eta_p^2=.01$), and 1.10 ($\eta_p^2=.01$), respectively, $p>.05$). Control participants rated the valence and arousal of physical pleasant images to be

significantly higher than social ($t(52) = -2.13, -2.15, p < .05$). Individuals with schizophrenia rated physical arousal higher than social ($t(52) = -2.25, p < .05$) but there was no difference in the valence ratings ($t(52) = -.89, p > .05$).

Figure 16: Mean consummatory ratings (error bars represent 1 standard error)



** = significant at $p < .05$,

There were no differences between physical and social anticipatory ratings so these ratings were combined for further analyses.

6.3.4 Anticipatory - Consummatory Discrepancy Scores

There were no differences between groups in the anticipatory and consummatory ratings for the four images used to calculate the discrepancy scores with the exception of mean Consummatory Low Valence, which was lower in people with schizophrenia (see Table 20).

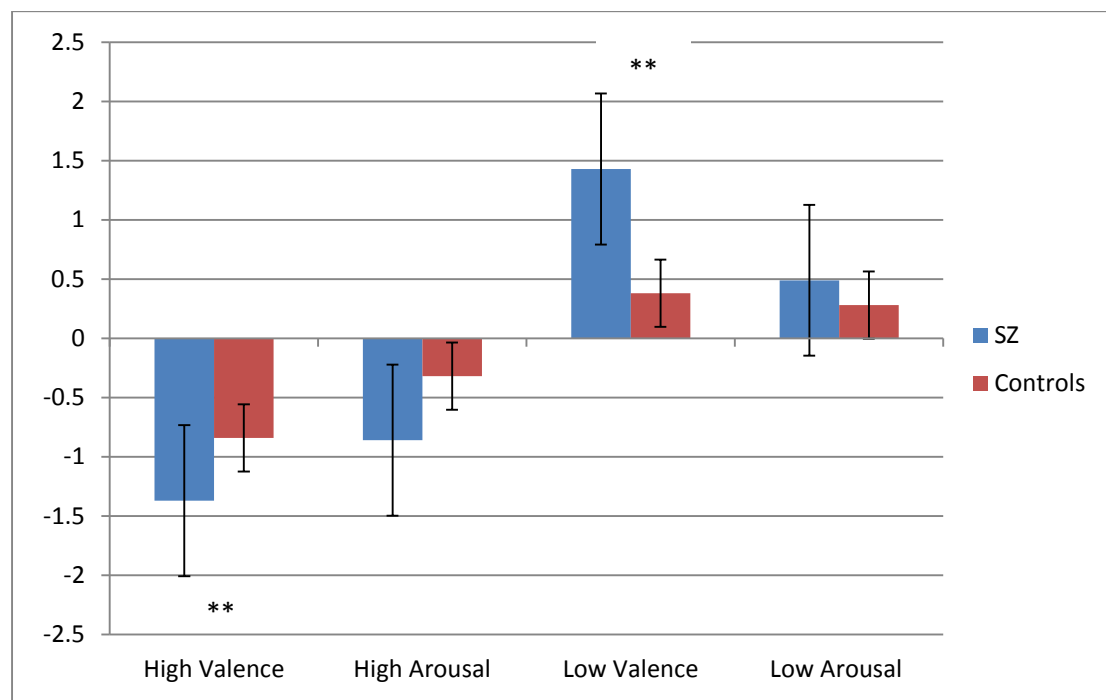
Table 20: Mean (SD) anticipatory and consummatory ratings used to calculate the discrepancy scores for each category

		HC Mean (SD)	SZ Mean (SD)	Comparison: One-way ANOVA
Consummatory	↑V	7.98 (0.87)	7.97 (1.47)	$F(1, 97)=.002, \eta_p^2=.0001, p=.97$
	↑A	5.82 (2.11)	6.36 (2.12)	$F(1, 97)=1.58, \eta_p^2=.02, p>.1$
	↓V	5.75 (1.28)	4.72 (1.59)	$F(1, 97)=12.47, \eta_p^2=.12, p<.001$
	↓A	4.60 (1.94)	4.42 (2.01)	$F(1, 97)=.21, \eta_p^2=.002, p>.1$
Anticipatory	↑V	7.02 (1.22)	6.57 (1.48)	$F(1, 94)=2.52, \eta_p^2=.03, p=.1$
	↑A	5.39 (2.23)	5.37 (2.14)	$F(1, 94)=.002, \eta_p^2=.0001, p>.1$
	↓V	6.25 (1.29)	6.14 (1.70)	$F(1, 92)=.12, \eta_p^2=.001, p>.1$
	↓A	4.78 (1.99)	5.11 (2.00)	$F(1,92)=.66, \eta_p^2=.01, p>.1$

↑= high, ↓=low, V=valence, A=arousal.

The overall discrepancy score was significantly larger in the schizophrenia group than in the control group ($F(1, 90) = 14.87, \eta_p^2=.14, p<.0001$). Individual discrepancy scores for each category of image were then compared between groups (see Figure 17). A score of 0 reflects no difference, less than 0 is an *underestimation* of actual pleasure and above 0 is an *overestimation* of actual pleasure. Individuals with schizophrenia significantly overestimated pleasure for images rated low ($F(1,94) = 13.67, \eta_p^2=.13, p<.0001$) while significantly underestimating pleasure for images rated high ($F(1, 94) = 4.29, \eta_p^2=.05, p=.04$). There were no significant differences in arousal ($p>.1$).

Figure 17: Mean anticipatory-consummatory valence discrepancy scores for each category of image; error bars represent 1 standard error



**= significant at $p < .05$

6.4 Discussion

In this chapter a new task was employed to measure the discrepancy between anticipatory and consummatory pleasure, using stimuli tailored to each individual. This innovative score provides a more refined assessment of the experience of pleasure, and for the first time has allowed a direct comparison between these two components. This shows that there is a larger discrepancy between anticipatory and consummatory ratings in the schizophrenia group. Due to the range of stimuli used in this task it was possible to show that the direction of this discrepancy is dependent on the pleasantness of the stimuli. In other words, considering anticipatory pleasure in the context of the event or stimulus being anticipated is important. Previous studies that have asked for single anticipatory ratings or averaged across several stimuli are missing the dynamic nature of anticipatory processes. These findings suggest that people with schizophrenia do not have a stable anticipatory

pleasure deficit but do vary their anticipation in accordance with the future event it is related to. However, although the pattern is similar to controls it is more extreme in people with schizophrenia, suggesting there is some dysregulation in this anticipatory process.

These results show that depressed and disorganised symptoms are associated with anticipatory pleasure ratings, whereas PANSS negative and the CAINS subscales were only associated with consummatory pleasure. Unexpectedly, the PANSS depressed subscale correlated *positively* with anticipatory ratings, this scale includes “depression”, “anxiety” and “guilty” items and it may be that the anxiety scores have inflated the reduced pleasure rating which was expected to be associated with depression. There is some evidence from the neuroimaging literature that co-morbid anxiety increases the reduced reward responses usually observed in people with depression (Gorka et al., 2014). The association of PANSS disorganised scores with anticipatory ratings implicates cognition in this process. However, this subscale is only a proxy measure and consists of attention, difficulty with abstract thinking and conceptual disorganisation (Wallwork et al., 2012). The lack of an association between anticipatory pleasure and the experiential negative symptom measures - PANSS negative and CAINS experiential - refutes the hypothesis of the TEP model that anticipatory pleasure is a significant contributor to these scores (Cohen et al., 2011).

An examination of potential moderators replicated the finding that current mood influences both anticipatory and consummatory ratings of pleasure in controls (Gilbert & Wilson, 2007; Larson et al., 2013; Wilson & Gilbert, 2005). However, these analyses found that medication does not appear to be a moderator of pleasure ratings. Chlorpromazine equivalent dosages were not associated with pleasure ratings, nor did different classes of anti-psychotic medication impact differently on the findings. This is in contrast with some evidence from the neuroscience literature (Juckel, Schlagenhauf, Koslowski, Filonov, et al., 2006; Lataster et al., 2011) but consistent with other studies using experimental paradigms to assess anticipatory and consummatory pleasure (Choi et al., 2013; Trémeau et al., 2014). As this is the only study to use an experimental task with good reliability data it adds a more robust finding to this mixed field of results regarding the role of medication in the experience of pleasure.

The results largely replicated the finding that consummatory pleasure is intact in people with schizophrenia (Cohen & Minor, 2010). Separating stimuli into physical and social categories has also shown there to be higher ratings for the physical compared to social stimuli in controls. This preference does not appear in individuals with schizophrenia. The correlational analyses suggest that experiential symptoms are associated with physical image ratings specifically, which may have contributed to the lower ratings in the schizophrenia group. There is also evidence to suggest that threat perception in individuals with schizophrenia is specifically heightened to non-social stimuli compared to faces, possibly due to difficulties processing social stimuli (Henry, Von Hippel, Ruffman, Perry, & Rendell, 2010; Lysaker et al., 2014; Pinkham et al., 2014).

The finding that anticipatory ratings are similar between the clinical and the control groups is in line with some previous experimental literature (Choi et al., 2013; Trémeau et al., 2010). However, by comparing stimuli of high and low pleasantness the COP task reveals a pattern of both under- and over-anticipation and a larger overall discrepancy in schizophrenia. This effect may have been lost in other studies which only included one rating of anticipatory pleasure (Choi et al., 2013; Trémeau et al., 2014) and did not control for the pleasantness of the stimuli being anticipated. The issue of relativity is highlighted in these findings; anticipatory pleasure must be considered *relative* to what is being anticipated and should not be measured without this context.

These findings suggest individuals with schizophrenia have difficulty differentiating very pleasant from less pleasant stimuli when anticipating. This may lead to low motivation to engage in activities, particularly ones that were previously enjoyable, as these are not distinguishable from less appealing activities. This pattern of anticipation may also explain why pleasure is reported as low by people with schizophrenia on questionnaires which tend to focus on the individual's reflections or thoughts on pleasurable activities (Cohen et al., 2011).

6.4.1 Implications & Future Directions

A larger discrepancy between anticipatory and consummatory pleasure in the context of intact consummatory pleasure has important implications for interventions for

anhedonia and negative symptoms. Psychological interventions such as Cognitive Behavioural Therapy for psychosis (Elis et al., 2013) and Cognitive Remediation Therapy (Cella, Reeder, & Wykes, 2014) may be able to address this issue by supporting individuals to link their anticipation and actual experiences more explicitly, resulting in more accurate predictions of future emotions. This could involve strategies such as an activity and pleasure diary or more intensive recall of previous experiences i.e. focusing on engaging all the senses when remembering to create a more detailed representation (Favrod, Giuliani, Ernst, & Bonsack, 2010; Tarrier, 2010). Cognitive Remediation Therapy focuses on errorless learning and this technique may aid people with schizophrenia to use positive feedback (Wykes, Reeder, Corner, Williams, & Everitt, 1999) as well as previous positive experiences to drive decisions and behaviour.

It is important to note that the same pattern is seen in controls as it suggests future therapies need not target accurate anticipation but a reduction in the anticipatory-consummatory discrepancy. It will be important to consider the nature of the event or activity being anticipated as it seems this may determine whether people with schizophrenia need to increase or decrease their anticipation. The COP task may be a useful outcome measure in trials of interventions targeting low pleasure and motivation. The use of this task experimentally in future work could further elucidate the nature of the biases present in the general population. It is important to continue to examine anticipation in controls as replication of these findings would contribute to the identification of a target outcome for interventions focused on anticipatory processes.

The work from this chapter has been published:

Edwards CJ, Cella M, Tarrier N, Wykes T. Predicting the future in schizophrenia: The discrepancy between anticipatory and consummatory pleasure. *Psychiatry Res.* 2015 Jul 6. pii: S0165-1781(15)00405-9. doi:10.1016/j.psychres.2015.05.091. [Epub ahead of print] PubMed PMID: 26233824.

Chapter 7: Validity and Acceptability of Experience Sampling Methodology in a Community Sample with Schizophrenia and a Control Group

7.1 Introduction

Experience sampling conveys many benefits to researchers including providing insight into how difficulties manifest in the everyday life environment. The use of this method provides participants with opportunities to report problems to clinicians that may not otherwise be identified. However, this method could also be considered intrusive and demanding for participants as they often have to carry booklets or devices with them and may be disturbed repeatedly during their daily routines. This potential burden could not only reduce the acceptability of the approach for participants but also the validity of the findings. If participants' usual routines are disrupted extensively then data are not gathered from typical behaviours and therefore does not provide valid insight into everyday life. There is also the potential issue of responsivity, where individuals change their daily routines to complete more questionnaires or provide different answers. This may also reduce the validity of the findings as the results are again not reflective of the individual's typical activities.

Before interpreting the findings gathered using ESM it is important to establish the validity of this approach. A limited number of studies including people with schizophrenia have reported feasibility data but no study has yet reported data on acceptability or external validity. A study using this method to assess positive symptoms found that participants were able to complete over 80% of questionnaires (Palmier-Claus et al., 2012). Two other studies also reported this method being feasible in inpatient settings (Kimhy, Vakhrusheva, Liu, et al., 2014) and in an outpatient group with severe mental disorders (Kimhy et al., 2012). These initial findings have led to preliminary studies showing that mobile technology also has good feasibility as an intervention (Ben-Zeev et al., 2014).

As experience sampling methodology is increasingly used it is also important to explore factors that may affect adherence rates and how this in turn may affect the validity of the findings. Assessments conducted over several days may be affected by fatigue and adherence rates could fluctuate. If questionnaire completion varies consistently at certain times of the day or across the week this could introduce bias in the results with these periods of time subsequently under-represented in the data. This is a particular concern in studies including people with high levels of negative symptoms, especially those reporting low motivation (Schlosser et al., 2014). Studies have been conducted successfully with individuals with high negative symptoms in the past (Gard, Sanchez, Starr, et al., 2014). The current study adds to this previous research by including a larger sample with a wider range of negative symptoms. This provides the opportunity to replicate the feasibility findings in this group as well as examine the acceptability and validity for the first time. Medication may also have an effect on ESM completion rates, particularly in the morning, as research shows that the sleep-wake cycle of people taking antipsychotic medications can be altered (Afonso, Brissos, Canas, Bobes, & Bernardo-Fernandez, 2014). There is limited data currently available on the acceptability and validity of ESM in a control group. Without this information, it is difficult to draw conclusions from data collected in this group. Responsivity is also a concern in studies including control participants as they may be influenced by social desirability effects resulting in changes to their patterns of behaviour whilst they are being monitored.

The aim of this study was to report both the validity and acceptability of an ESM study examining emotional experiences and activity in a population with chronic schizophrenia living in the community and controls. Adherence was investigated by looking at the rate of responding during the day and across the week as well as overall questionnaire completion rates in an attempt to replicate previous findings of high response rates. This also allowed the identification of any days or time-points with reduced completion rates that might affect the validity of the data reported. Similarly, the relationships between symptoms, medication and adherence rates were assessed to understand whether individuals with more severe symptoms or higher medication dosages had greater difficulty responding to the questionnaires. If this is the case then this suggests that individuals with severe symptoms and/or those prescribed high levels of medication

may be under-represented in the findings, limiting the generalisability of the study. Detailed information on acceptability and external validity was evaluated using a feedback questionnaire with data collected from both groups on the acceptability of the experience, training and any disruption or responsivity caused by taking part. This was important to investigate as if individuals report high levels of disruption this could limit the validity of the findings.

The hypotheses were as follows:

- (i) There is no significant difference in completion rates in people with schizophrenia and controls.
- (ii) Both groups find the experience acceptable and report minimal disruption.

The following research questions were investigated without a priori directional hypotheses:

- (iii) Is there a fatigue effect in either group with fewer questionnaires completed towards the end of the week?
- (iv) Do questionnaire completion rates vary at different time-points across the day in either group?
- (v) Do medication and negative symptoms correlate with questionnaire completion rates in people with schizophrenia? Do people who demonstrate low adherence (as defined by a median-split) have higher levels of symptoms and medication?

7.2 Method

7.2.1 Sample

All participants who completed both the consummatory and anticipatory sections of the COP task were invited to take part in the experience sampling week. The sample was therefore recruited following the same inclusion/exclusion criteria as described in detail in Chapter 3 (Pages 108-110).

7.2.2 Experience Sampling Protocol

This is also described in detail in Chapter 3 (Page 102-103). The experience sampling questionnaire was administered using a PsyMate, an electronic device which beeped 7 pseudo-random times a day between 8.30am and 10pm for 6 days.

7.2.3 Measures

See Chapter 3 (Pages 113-117) for further details of all the measures included in this study.

1. Adherence: completion of the questionnaire was recorded at each time-point, 7 times a day for 6 days. The number of questionnaires completed was then totalled for each day and the week to assess the level of adherence. The time at which each “beep” occurred was also recorded.
2. PANSS: to assess symptom levels (Kay et al., 1987).
3. Medication: chlorpromazine equivalent dosages were calculated (Woods, 2003).
4. Experience Sampling Feedback Questionnaire: the items included in each category, namely acceptability, disruption and training, are listed below in Table 21.

Table 21: Categorisation of items in the experience sampling feedback questionnaire; all items rated from 1 (not at all) to 7 (very much so)

Acceptability	Disruption	Training
The questionnaire was easy to complete.	The experience sampling device disrupted my everyday life.	The training I received in the briefing session was adequate to use the device for the whole week.
I found it embarrassing when the alarm sounded around other people.	At times I had to rush to complete the questionnaire.	I felt supported by the research team during the experience sampling week.
I enjoyed the experience sampling week.	The experience sampling device stopped me from doing my usual activities.	
	I found it easy to remember to carry the experience sampling device with me.	
	The experience sampling device changed my usual routine.	

7.2.4 Analyses

Demographic information: age, gender, ethnicity, education, employment and medication are reported for both groups.

7.2.4.1 Adherence

The median and interquartile range of the overall completion rate (% of questionnaires completed) is reported as this is a more detailed representation of the variance of the data than the mean and standard deviation. A 20% minimum threshold of questionnaires completed was set to ensure adequate external validity of the ratings given allowing conclusions to be drawn regarding the wider population. This threshold has been used in previous research (Oorschot et al., 2013).

7.2.4.2 Fatigue Effects

The average percentage of questionnaires completed for each beep (1-7) and day (1-6) is reported separately for each group to identify any fatigue effects during the assessment period. The percentage of questionnaires completed at each beep and day are compared within-groups using paired t-tests to ascertain whether any are significantly reduced relative to other times/days in either group and therefore identify where fatigue may be occurring.

7.2.4.3 Potential Moderators of Adherence

Pearson's correlation analyses or Spearman's Rank correlations for any non-parametric data were conducted to examine the relationships between medication, symptom severity and number of questionnaires completed at beeps and days identified as significantly reduced. Symptoms and medication may limit the ability of people with schizophrenia to complete questionnaires. A median-split of adherence scores was conducted and those in the lower half were classed as individuals who demonstrated "low adherence", while those in the upper half were classed as "high adherence". The symptoms and medication dosages of individuals who had low adherence were compared with those with high adherence to assess whether these had a larger effect in the low adherence group. To examine the impact of employment on availability to complete questionnaires in

the control group, completion rates in unemployed individuals were compared to employed individuals.

7.2.4.4 Acceptability and External Validity

Experience, training and disruption scores were considered to assess acceptability and external validity, with a score of 1-3 (total range 1-7) considered a negative rating. The correlation between disruption and questionnaires completed was calculated to examine whether there was correspondence between the subjective experience of the week and actual completion rates.

7.3 Results

5 people (14%) with a diagnosis of schizophrenia and 1 control participant (2%) did not meet the validity threshold of >20% of questionnaires completed and were excluded from future analysis. One person in the schizophrenia group reported finding the questions anxiety-provoking and withdrew their participation. The other four individuals who did not complete sufficient questionnaires did not give a reason for this. There were no differences between those included and excluded in age, medication or symptoms (see Table 22). No PsyMates were lost or damaged during the study. The characteristics of those who took part in the ESM study are detailed below; this is a sub-sample of those who completed the COP task (see Chapter 3, Page 111). Of these 37 participants, 6 people were prescribed typical anti-psychotics, 29 people were prescribed atypical anti-psychotics and 2 people were not currently prescribed anti-psychotic medication.

Table 22: ESM sample characteristics

Demographics	SZ (n=33)	HC (n=43)
Age	42.27 (8.85)	39.56 (10.70)
Gender (% Male)	75.8%	69.8%
Ethnicity	White = 33.3% Black = 63.6% Asian = 3.1%	White = 51.2% Black = 43.9% Asian = 13.9%
Education	SS = 42.4% FE= 39.4% HE = 18.2%	SS = 9.3% FE= 18.6% HE = 72.1%
Employment (% Unemployed)	91%	30%
Mean Chlorpromazine Equivalent Dosage (SD)	381.64 (362.72)	
PANSS Negative Mean (SD)	17.85 (4.24)	
PANSS Disorganised Mean (SD)	6.21 (2.12)	
PANSS Depressed Mean (SD)	7.10 (2.78)	
PANSS Positive Mean (SD)	8.88 (4.66)	
PANSS Excited Mean (SD)	5.03 (1.26)	

SS= secondary school, FE = further education (16-18yrs), HE= higher education (18yrs+).

7.3.1 Adherence

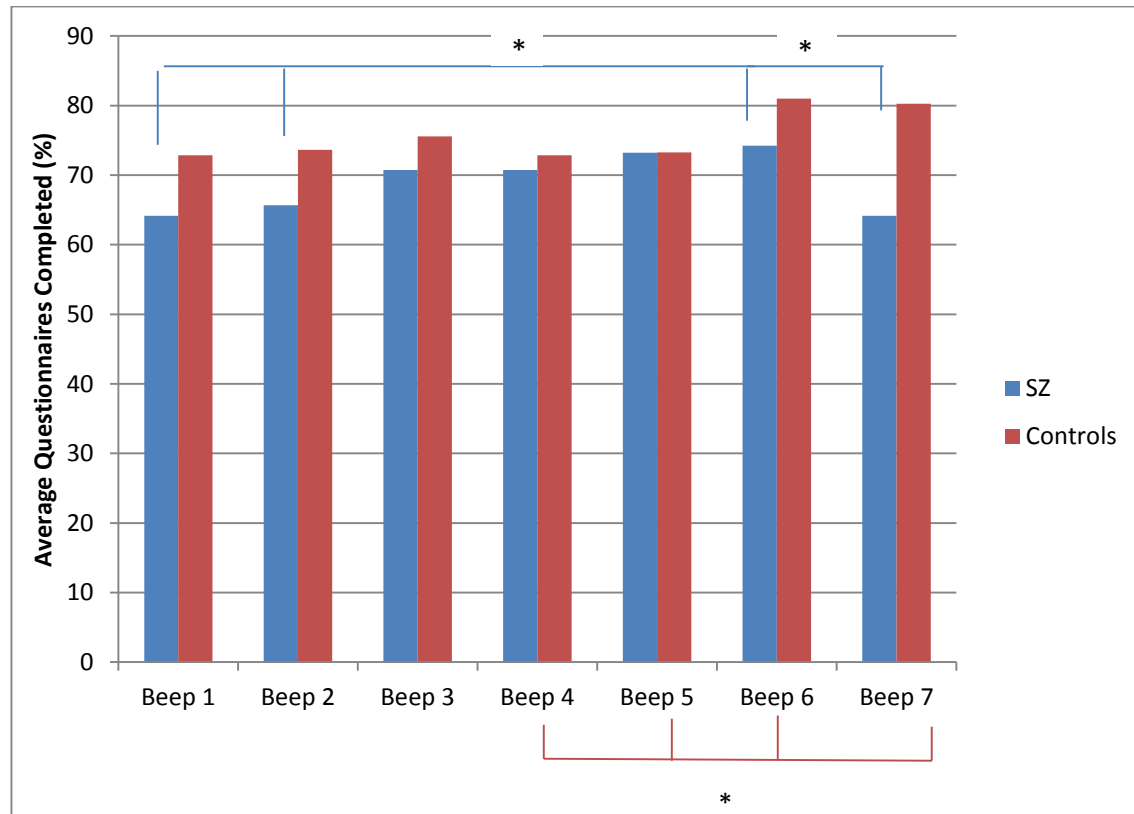
Participants with a diagnosis of schizophrenia completed 71% (IQR=28.5), this is comparable to the 81% (IQR=26) completed by controls and is not significantly different ($\chi^2(30) = 30.17$, $p=.46$). The larger IQR in the schizophrenia group reflects a lower minimum of 21%; the minimum is 32% in the control group. Two control participants and one person in the schizophrenia group completed all of the questionnaires.

7.3.2 Fatigue Effects

To identify any variations in completion rates over time the number of questionnaires completed throughout the day were examined in each group (see Figure 18). People with schizophrenia complete fewer questionnaires at beep 1 and 2 compared to beep 6 ($p<.05$). They also complete fewer questionnaires at beep 7 compared to beep 6 ($p<.05$). The average times beeps 2 and 6 occur suggests an optimum time window for completion of questionnaires between 11.30am and 7pm in the schizophrenia group.

In the control group fewer questionnaires were completed at beeps 4 and 5 compared to beeps 6 and 7. The average time of beep 4 in the control group was 3pm and beep 5 was 5.30pm, whereas beep 6 and 7 were at 7.07pm and 9.01pm respectively. Their optimum time window was therefore 8.30am-3pm and 7pm-10pm.

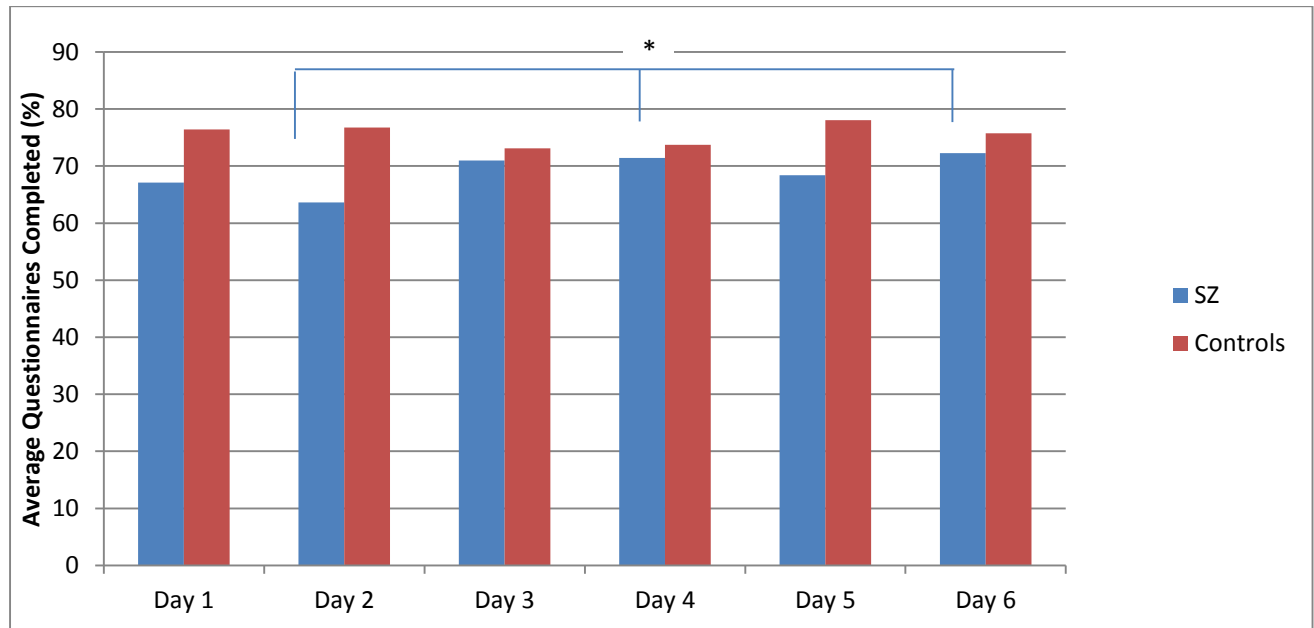
Figure 18: The average percentage of questionnaires completed at each beep (1-7) during the experience sampling week



*= $p < .05$, — = HC within-group comparison, — = sz within-group comparison.

Response rates were also examined for each day to identify whether participants complete fewer questionnaires at any particular point in the week (see Figure 19). The response rates on each day did not vary considerably in either group although people with schizophrenia did answer fewer questionnaires on day 2 compared to days 4 and 6 ($p < .05$).

Figure 19: The average number of questionnaires completed on each day (1-6) during the experience sampling week



*= $p < .05$, — = sz within-group comparison.

7.3.3 Potential Moderators of Adherence: Symptoms, Medication and Employment.

Spearman's Rank correlations were conducted between completion rates and the medication dosages due to the large standard deviation of the medication data. In the schizophrenia group the overall percentage of questionnaires completed did not significantly correlate with chlorpromazine equivalent levels ($r = -.15$, $p = .46$), total PANSS score ($r = .12$, $p = .52$) or any PANSS subscales ($r = -.09-.12$, $p = .49-.91$) except PANSS depressed at trend level ($r = .32$, $p = .07$). There were no significant correlations between beeps 1, 2 or 7 or day 2 (which had significantly reduced completion rates) and medication ($r = -.22-.05$, $p = .23-.79$) or PANSS total ($r = -.03-.10$, $p = .50-.97$). Participants in the schizophrenia group who completed fewer than 50% of the beeps at time-point 1 and 2 did not significantly differ from the other participants in their levels of medication ($F(1, 31) = .41$, $p = .53$), total PANSS score ($F(1, 31) = .90$, $p = .35$) or any PANSS subscales ($F(1, 31) = .001-1.37$, $p = .25-.98$).

Unemployed individuals in the control group completed questionnaires more often at beeps 6 and 7 at trend level compared to those in employment (beep 6 $F(1, 41) = 2.76$, $p = .10$, beep 7 $F(1, 41) = 3.64$, $p = .06$).

7.3.4 Acceptability and External Validity Questionnaire Ratings

In the control group 2% ($n=1$) of people found the experience of taking part in the ESM study negative; this was not reported by any participants in the schizophrenia group. The training and support given by the researcher during the week was reported as inadequate by 9% ($n=3$) of the schizophrenia group and by no participants in the control group. The level of disruption was reported as negative by 9% ($n=3$) of people with schizophrenia and by no control participants. The level of disruption correlated with questionnaire completion rates in people with schizophrenia (Pearson's $r = -.43$, $p = .01$) but not the control group (Pearson's $r = -.15$, $p = .32$).

7.4 Discussion

The data supports experience sampling methodology as a valid and acceptable research tool in both individuals with high levels of negative symptoms living in the community and a control population.

7.4.1 Adherence and Moderators of Completion Rates

The overall adherence rate was high in both groups and very few people failed to reach the minimum threshold for inclusion in the analyses. This confirms that experience sampling methodology has high feasibility in a community sample with high levels of negative symptoms and controls. Examining the response rates at each beep revealed that people with schizophrenia missed more questionnaires in the morning and late in the evening. This is probably due to disrupted sleep-wake cycles in this group which often result in them waking later in the day (Afonso, Figueira, & Paiva, 2014). Unfortunately sleep-wake patterns were not measured directly in the study. A thorough assessment of side-effects, including sleep disruption, would be a more sensitive measure than medication dosage

alone to assess the impact of medication on questionnaire completion. Only two people in the current sample were not currently prescribed medication preventing a comparison between medicated and unmedicated individuals. Replication of these compliance rates in a larger non-medicated sample would support the conclusion that medication is not a barrier to questionnaire completion. Lower adherence overall and specifically in the morning appears to be unrelated to symptom levels which is encouraging for including participants with a wide range of symptom severity in future studies. The PANSS depression subscale correlated positively with the completion rates. This subscale includes “depression”, “anxiety” and “guilty feelings” items. Similarly to the positive association seen in the COP task study between depression and anticipation it may be that levels of anxiety inflate the reduced adherence that might be expected in those with high levels of depression. There was sufficient data at all the time points across the day for inclusion in analyses in both groups despite these time-points showing reduced completion rates. However, future studies may wish to adapt the protocol to fit more beeps within 11.30am-7pm as this could increase questionnaire completion.

It seems the protocol suited the lifestyle of control participants although slightly more questionnaires were completed in the evening by unemployed individuals, perhaps due to employed individuals going to sleep earlier. However, as the ESM device did not record periods of time spent asleep this is difficult to interpret conclusively. The finding that people with schizophrenia complete slightly fewer questionnaires on day 2 suggests that the check-in phone call may be having an effect in boosting adherence after this point. It could be more effective if conducted perhaps earlier in the day or during the first day of the assessment period.

7.4.2 Acceptability and Disruption

The experience of taking part was considered acceptable in the vast majority of participants which is encouraging for future research and lessens concerns about a high burden on participants. The levels of training and support offered during the week were also rated as adequate. Disruption to the week was considered acceptable by the vast majority of individuals. From this finding it can be inferred that the data collected should be considered as part of a typical week. This maximises the external validity of the findings

using this methodology. However, disruption was associated with completing fewer questionnaires in the schizophrenia group but not in the control group. This is unsurprising as the level of disruption was not considered intrusive by any control participants, and this may explain the slightly lower completion rates in the schizophrenia group. The association between disruption and adherence supports the argument that minimising disruption perhaps by reducing the number of beeps or avoiding difficult times of day may increase questionnaire completion.

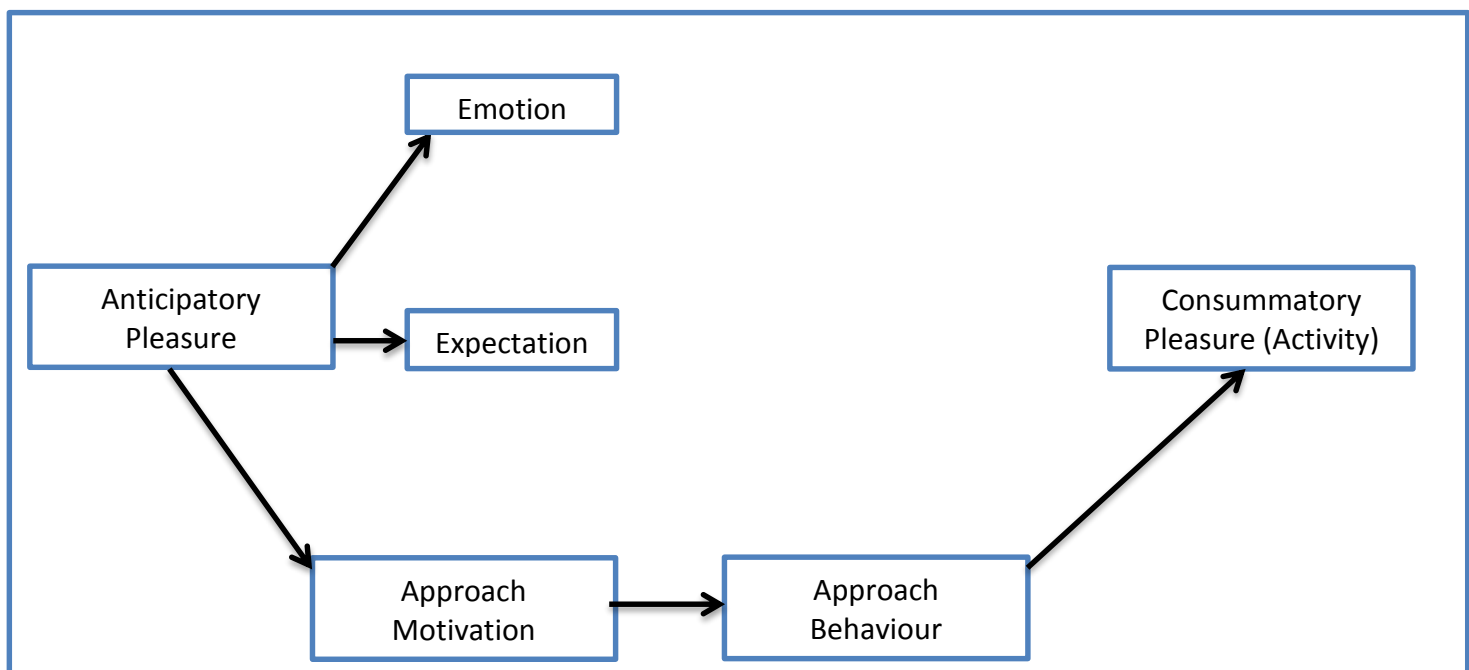
Future studies could integrate ESM and passive monitoring (heart rate, activity levels, GSR) prior to and during concurrent experience sampling to investigate adherence further when using this methodology. These additional measures would provide data on physiological arousal and stress which could inform researchers about the burden on participants. Information regarding the individuals' sleep-wake cycle could also be gathered using these additional methodologies. This would also enable correspondence between the data from the self-report experience sampling items and that sourced from the device to be assessed. The knowledge that the experience sampling study conducted in this PhD was acceptable and valid in both groups supports the conclusions drawn from the data collected using this methodology in the following chapters.

Chapter 8: An Experience Sampling Study of Pleasure, Motivation and Activity in Everyday Life

8.1 Introduction

The negative symptoms of schizophrenia have repeatedly been shown to be linked to poor functional outcomes (Foussias et al., 2011; Loas, Azi, et al., 2009). The Temporal Experience of Pleasure (TEP) model (Kring & Barch, 2014; Kring & Caponigro, 2010) has been at the forefront of research into the emotional and motivational deficits in schizophrenia. This has been discussed in detail in Chapters 1 and 2, but it is important to highlight how this model can serve as a base to posit hypotheses that can be tested (see Figure 20). Using ESM to examine these hypotheses has two main advantages: firstly the link between anticipatory processes and everyday life functioning can be assessed and secondly the longitudinal data allows temporal relationships between anticipation and future activity to be examined.

Figure 20: Section of the TEP model proposing the stages between anticipation and activity



Previous research has consistently found consummatory pleasure to be intact in people with schizophrenia (Cohen & Minor, 2010; Llerena et al., 2012). Therefore the focus of research has been on the components of the model proposed to contribute to activity: anticipatory pleasure (emotion + expectation), motivation and behaviours. The conclusions are mixed; self-report measures show reduced motivation and anticipatory pleasure in people with schizophrenia compared to controls (Chan et al., 2012; Mote et al., 2014; Reddy et al., 2014; Schlosser et al., 2014). However, see G. P. Strauss, Wilbur, et al. (2011) for the contrasting finding of increased anticipatory pleasure and reduced consummatory pleasure in people with schizophrenia. Laboratory-based tasks have reported different findings to self-report measures with some reporting increased or intact anticipatory pleasure and affective motivation in people with schizophrenia (Choi et al., 2013; Trémeau et al., 2010; Trémeau et al., 2014). Indeed, the findings from the research conducted using the COP task show abnormalities in anticipatory pleasure dependant on the stimuli presented (see Chapter 6). This emphasises the importance of placing anticipatory pleasure in the context of the stimuli being rated when considering this question, something which can be easily incorporated into an ESM study using everyday activities.

To understand and clarify the deficits reported in both laboratory and self-report measures, researchers have recently begun to use ESM. The findings from this method have also been mixed (as discussed in Chapter 1), with an early study finding reduced anticipatory pleasure in schizophrenia (Gard et al., 2007) whilst two recent, larger studies report increased anticipatory pleasure compared to controls (Brenner & Ben-Zeev, 2014; Gard, Sanchez, Cooper, et al., 2014). Motivation also appears to be intact in some contexts according to the findings from ESM studies (Gard, Sanchez, Starr, et al., 2014; McCormick et al., 2012). Many of the studies reported higher negative emotion in schizophrenia alongside comparable positive emotion to controls which has been described as affective ambivalence (Kimhy, Vakhrusheva, Khan, et al., 2014; Oorschot et al., 2013; Sanchez et al., 2014). This finding was replicated using the PANAS in the COP task study conducted (see Chapter 6). The effect of both negative and positive emotion in everyday life on anticipatory or consummatory pleasure has yet to be investigated. It may be that the presence of heightened negative emotion dampens the levels of enjoyment or motivation and limits

their capacity to drive activity. This study addressed this research question in its examination of the influence of context on anticipation.

ESM allows the assessment of social functioning and experiences in everyday life. Both similar and reduced enjoyment of social experiences have been reported in these studies and people with schizophrenia have indicated a preference to be alone more often (Janssens et al., 2012; Oorschot et al., 2013). The link between these emotional ratings of social experiences and engaging in interactions with other people is unclear, as both these studies report that people with schizophrenia spend a similar amount of time with others as controls do (Janssens et al., 2012; Oorschot et al., 2013). However, the wider literature reports reduced social functioning in people with schizophrenia, as measured with questionnaires and interviews, which shows no improvement with anti-psychotic treatment (Swartz et al., 2007).

These studies investigated the different components of the TEP model presented above but none examine the whole pathway to activity in everyday life providing a clear rationale for this study. The use of different measures to assess different TEP model components may explain the mixed findings and limits the conclusions that can be drawn regarding the nature of any deficits in schizophrenia. Measuring all the components of the model together using the same methodology was important as it enabled covariance analyses to be completed and the relative importance of each component to be assessed. The large amount of data collected during an ESM week (in this case, 42 questionnaires per person) allowed multiple hypotheses to be tested.

The TEP model also proposes that reduced anticipatory pleasure underlies the high experiential negative symptoms and poor functioning reported by people with schizophrenia (Cohen et al., 2011; Kring & Caponigro, 2010). Therefore, according to this hypothesis, anticipatory pleasure as measured by the ESM study should be associated with experiential negative symptom scores from the PANSS, CAINS and functioning as measured by the Time Use Survey. This hypothesis has already been examined in Chapter 6 using the anticipatory and consummatory ratings from the COP task. The findings from this chapter provided mixed support for this proposal; anticipatory pleasure correlated with PANSS depressed and disorganised subscale scores but in opposite directions. Furthermore,

consummatory pleasure ratings correlated with PANSS negative subscale and CAINS experiential subscale scores.

The overall aim of this study was to test the TEP model proposal that reduced anticipatory pleasure (consisting of both an expectation and a pleasure rating) in everyday life predicts reduced motivation and therefore reduced activity levels in people with schizophrenia compared to controls. The hypotheses were as follows:

- i. People with schizophrenia have reduced social, functional and leisure activities compared to controls.
- ii. People with schizophrenia have reduced social and non-social anticipatory pleasure compared to controls.
- iii. People with schizophrenia have reduced expectation that future events will occur compared to controls.
- iv. People with schizophrenia have reduced motivation for future events compared to controls.
- v. Anticipatory pleasure and expectation are associated with motivation and activity levels in both groups.
- vi. ESM ratings of anticipatory pleasure, but not consummatory pleasure are related to experiential negative symptoms scores on the PANSS and CAINS.

The ESM study also offered the opportunity to examine research questions regarding factors that have not yet been incorporated into the TEP model but that findings from other research suggests may be important to consider. The first of these was to attempt to replicate the previous finding that people with schizophrenia show a greater preference to be alone than controls. Additionally, the role of mood in the processes proposed in the TEP model is currently unclear. The prediction was that the finding of increased negative mood and similar positive mood to controls will be replicated. However, the research question as to whether this is associated with pleasure or motivation has not been investigated before so this was examined without a specific hypothesis in either direction. The control literature suggests that mood, as a feature of the individual's current context, is associated with forecasted pleasure (Gilbert & Wilson, 2007) but it is not clear from previous research if this is a stronger association in people with schizophrenia or controls. Enjoyment of the activity

they are currently engaged in is also a feature of the individual's context and the influence of this on anticipatory ratings was examined but again the direction of the hypothesis is not clear in the schizophrenia group although an association in the control group is expected from the literature (Wilson & Gilbert, 2005). If it is shown that context factors e.g. time of day, mood, enjoyment, play a role in anticipatory constructs then the TEP model will be adapted to incorporate these to make further progress in the field.

8.2 Method

8.2.1 Sample

Every participant who completed both the anticipatory and consummatory phases of the COP task was invited to complete the ESM phase of the study. Therefore, the inclusion/exclusion criteria are identical to those detailed in Chapter 3, Pages 108-110.

8.2.2 Measures

This study used the following measures; for full details see Chapter 3, Pages 113-117.

- Mini International Neuropsychiatric Interview (MINI) (Sheehan et al., 1998).
- Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987).
- Clinical Assessment Interview for Negative Symptoms (CAINS) (Kring et al., 2013).
- Experience Sampling Questionnaire
 - The questionnaire contained items assessing mood and consummatory pleasure during the current activity. It also assessed anticipatory pleasure, motivation and expectation for future activities. Current activity type and future activity type were also both recorded. Social and non-social ratings were included in the items. For the full questionnaire see Chapter 3, Figure 9, Pages 100-101.

8.2.3 Procedure

The full protocol for the experience sampling study is detailed in Chapter 3, Page 104. All participants carried the device with them for 6 days and were prompted to complete a questionnaire 7 times a day.

8.2.4 Analyses

This chapter will use a range of statistical analyses to test the hypotheses proposed in the introduction. Demographic information was compared between groups using chi-squared and t-test analyses as detailed in Chapter 3.

8.2.4.1 Are Activity Levels Reduced in People with Schizophrenia?

Number of occasions recorded in different activities and in different company was calculated as a percentage of the total number of beeps completed. These percentages were then compared between groups using one-way ANOVAs to address this hypothesis.

8.2.4.2 Between-Group Differences in the Components of the TEP Model

Multi-level linear modelling techniques are variations of unilevel linear regression analyses ideally suited to experience sampling data which creates three levels of analysis (beep level, day level, participant level). Clustered variation for each beep, day and participant is accounted for as random effects in the model; the effects of the predictors on the outcome variable are described as fixed effects. Models can be estimated with continuous or categorical outcomes. The commands XTMIXED for continuous outcome variables and XTMELOGIT for categorical outcome variables in Stata (Version 11.2) (StataCorp, 2009) were used for all analyses (Hartley et al., 2015; Kimhy et al., 2012). Effects from predictors in the multilevel model were expressed as β representing the fixed regression coefficient (see Chapter 3, Page 123 for more detail). Leisure and functional activities were examined as the main outcome variables as these are the activities clinicians seek to increase. Models were estimated examining the effect of diagnostic group ("1"

controls, “2” schizophrenia group) on the dependent variable. Interaction variables incorporating the independent variable and group were entered into all the models to examine whether the effect of the independent variable on the dependent variable is significantly different between groups.

8.2.4.3 Potential Confounders

If any group differences were identified in the independent variables in each model these were entered as co-variables in future models to control for this difference while examining the relationships between other variables. For example, if consummatory pleasure is consistently higher in the control group for leisure activities this may confound any differences in anticipatory pleasure as high reported enjoyment “in the moment” is likely to predict higher anticipated enjoyment. It is important to examine if a difference in anticipatory pleasure is present between groups when any differences due to consummatory pleasure are controlled for in order to answer the research questions accurately.

8.2.4.4 Association between Current Context (Mood and Enjoyment) and Anticipatory and Expectation Ratings

Analyses were then conducted for each group separately to identify any effect of mood and consummatory pleasure on anticipatory pleasure and expectation ratings made at the same time-point. Negative and positive mood were entered as possible confounders in all analyses. Another statistical method that can be used to examine the influence of context is variation partition coefficient (VPC) analyses (Goldstein et al., 2002). These values reflect the amount of variability in each construct in the model attributable to the person, day or time (see Chapter 3, Page 123 for more detail). These are reported for each level (participant, day and beep) and a high value represents a large amount of variability between people, from day-to-day or from beep-to-beep. A high VPC at *participant* level suggests the variable is stable over time, a high VPC at *day or beep* level suggests it varies substantially over time.

8.2.4.5 Predictors of Activity

Time-lagged analyses were conducted using multi-level models; variables recorded at the previous time-point are entered into the models as predictors of an activity occurring at the next time-point to address the final hypothesis of whether anticipatory pleasure, expectation and motivation predict future activity in both groups.

8.2.4.6 Hypothesised Relationship between Anticipatory Pleasure and Experiential Negative Symptoms

The TEP model hypothesises that an anticipatory pleasure deficit underlies experiential negative symptoms and poor functioning levels. To test this hypothesis Pearson correlational analyses were conducted between anticipatory and consummatory pleasure ratings from the ESM study and the following subscales: PANSS negative, disorganised and depressed and CAINS experiential scores. A multi-level model is not an appropriate statistical technique to use when examining relationships with baseline assessments conducted at one time-point only as the dependent (baseline measure) and independent (ESM rating) variables are not all repeated at each time-point violating the assumptions of the model. Averages were calculated of the experience sampling ratings across the week for each participant. Although this loses some of the information from the ESM week it was necessary to transform the data for correlational analyses. The Benjamini & Hochberg False Discovery Rate (see Chapter 3, Page 120) was applied to all these analyses to correct for multiple correlations (Benjamini & Hochberg, 1995).

8.3 Results

As discussed in Chapter 7, 5 people in the schizophrenia group and 1 in the control group failed to complete >20% of the ESM questionnaires during the week and were excluded from the analyses. The final sample included 33 people who completed a total of 951 ESM questionnaires in the schizophrenia group and 43 people in the control group who completed 1,356 ESM questionnaires in total.

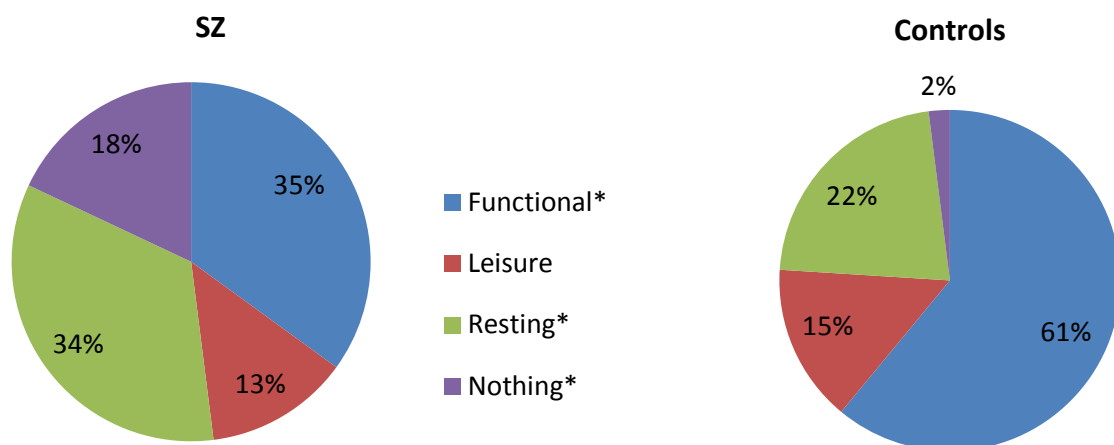
8.3.1 Demographics

The demographics of both groups can be seen in Table 22, Chapter 7, Page 171. The groups were balanced for age and gender, but not for ethnicity ($X^2= 7.04$, $p<.05$). People with schizophrenia had lower levels of education and employment than the control group Education: $X^2= 22.72$, $p<.05$; Employment: $X^2= 32.16$, $p<.05$).

8.3.2 Everyday Life Activity Levels

People with schizophrenia reported a similar amount of leisure activities compared to controls ($F(66)=.09$, $p=.76$) (see Figure 21). Controls reported significantly more functional activities ($F(66)=53.12$, $p=.000$) and described significantly fewer activities as “nothing” ($F(66)=29.98$, $p=.000$) or resting ($F(66)=9.84$, $p=.002$).

Figure 21: Proportion of time-points selected in each activity across the whole ESM week



*= significant at $p<.05$

8.3.3 Mood, Pleasure, Expectation and Motivation Between-Groups Analyses

Mood ratings across the week were averaged for each individual participant using a mean of 31.53($SE=1.25$) questionnaires for controls and 28.82($SE=1.28$) for the schizophrenia group. Mean functional consummatory ratings were calculated using an average of 19.19($SE=1.03$) questionnaires for controls and 10.12($SE=1.04$) for people with schizophrenia. The averages of these ratings across all the participants are presented in Table 23 below.

Table 23: Mean ESM ratings for each group averaged across the 6 study days

Average Rating Across 6 Days		HC	SZ
Positive Mood Mean (SE)		17.47 (.09)	17.98 (.12)
		Beeps(N) Mean (SE)=31.53 (1.25)	Beeps(N) Mean (SE)=28.82 (1.28)
Negative Mood Mean (SE)		9.88 (.09)	19.52 (.23)
		Beeps(N) Mean (SE)=31.53 (1.25)	Beeps(N) Mean (SE)=28.82 (1.28)
Functional Activities	Consummatory Pleasure Mean (SE)	4.5 (.02)	5.22 (.03)
		Beeps(N) Mean (SE)=19.19 (1.03)	Beeps(N) Mean (SE)=10.12 (1.04)
	Motivation Mean (SE)	9.52 (.04)	9.76 (.07)
		Beeps(N) Mean (SE)=17.53 (0.15)	Beeps(N) Mean (SE)=12.73 (0.25)
	Expectation Mean (SE)	10.91 (.03)	9.75 (.07)
		Beeps(N) Mean (SE)=17.53 (0.15)	Beeps(N) Mean (SE)=12.73 (0.25)
Leisure Activities	Anticipatory Pleasure Mean (SE)	4.56 (.02)	5.35 (.04)
		Beeps(N) Mean (SE)=17.53 (0.15)	Beeps(N) Mean (SE)=12.73 (0.25)
	Consummatory Pleasure Mean (SE)	5.53 (.02)	5.53 (.04)
		Beeps(N) Mean (SE)=4.7 (0.58)	Beeps(N) Mean (SE)=3.8 (0.71)
	Motivation Mean (SE)	10.93 (.05)	9.74 (.08)
		Beeps(N) Mean (SE)=12.72 (0.14)	Beeps(N) Mean (SE)=10.88 (0.19)
Leisure Activities	Expectation Mean (SE)	10.82 (.03)	9.94 (.08)
		Beeps(N) Mean (SE)=12.72 (0.14)	Beeps(N) Mean (SE)=10.88 (0.19)
	Anticipatory Pleasure Mean (SE)	5.32 (.03)	5.69 (.03)
		Beeps(N) Mean (SE)=12.72 (0.14)	Beeps(N) Mean (SE)=10.88 (0.19)

The first analyses examined whether there is a group difference in mood by estimating multi-level models (Table 24). Negative mood was found to be significantly higher in the schizophrenia group and was therefore controlled for in all multi-level models examining the effect of diagnostic groups. There was no difference in positive mood between groups. However, positive mood inversely predicts negative mood in all the models so it is controlled for in analyses with negative mood as the outcome variable.

Table 24: Multi-level models of between-group differences in positive and negative affect

Multi-Level Model (N=2287 beeps)	Outcome Variable	Predictors	Beta Coefficient (SD)	P Value	95% Confidence Intervals
Model 1	Negative Mood	Group	10.35 (1.59)	.0001	7.23-13.45
		Positive Mood	-.27 (.07)	.0001	-.41- -.12
		Positive Mood x Group	-.03 (.05)	.49	-.13-.06
		Intercept	4.81 (2.41)	.05	.09-9.52
Model 2	Positive Mood	Group	.22 (.98)	.82	-1.70-2.14
		Negative Mood	-.55 (.06)	.0001	-.68- -.43
		Negative Mood x Group	.19 (.04)	.0001	.12-.26
		Intercept	20.85 (1.46)	.0001	17.99-23.72

Between-group differences in consummatory pleasure, anticipatory pleasure, motivation and expectation were then examined (Table 25, Models 3-10). Consummatory pleasure was significantly higher in the schizophrenia group for both leisure and functional activities (see Table 25). Consummatory pleasure was then entered along with negative affect as covariates in Models 5-10 which test whether group predicts differences in anticipatory pleasure, motivation and expectation. Anticipatory pleasure was also

significantly higher in the schizophrenia group for both functional and leisure activities. Motivation and expectation were not different between the groups for leisure activities. Motivation was also similar for functional activities between groups but expectation was lower in the schizophrenia group.

Table 25: Multi-level models of between-group differences in consummatory pleasure, anticipatory pleasure, expectation and motivation

Multi-Level Model (n=beeps)	Outcome Variable	Predictors	Beta Coefficient (SD)	P Value	95% Confidence Intervals (p value)
Model 3 (n=327)	Leisure	Group	.98 (.41)	.02	.18-1.78
	Consummatory Pleasure	Negative Mood	-.08 (.05)	.09	-.18-.01
		Negative Mood x Group	.001 (.03)	.97	-.05-.05
		Intercept	5.33 (.61)	.0001	4.14-6.52
Model 4 (n=1158)	Functional	Group	.60 (.34)	.08	-.07-1.26
	Consummatory Pleasure	Negative Mood	-.18 (.03)	.0001	-.24- -.13
		Negative Mood x Group	.07 (.02)	.0001	.03-.10
		Intercept	5.13 (.48)	.0001	4.20-6.06
Model 5 (n=389)	Leisure	Group	.61 (.15)	.0001	.31-.91
	Anticipatory Pleasure	Negative Mood	.03 (.03)	.23	-.02-.09
		Average Consummatory Pleasure	.61 (.15)	.0001	.31-.91

		Group x Average Consummatory Pleasure x Negative Mood.	-.01 (.002)	.01	-.01- -.002
		Intercept	1.14 (1.08)	.29	-.98-3.26
Model 6 (n=1173)	Functional Anticipatory Pleasure	Group	.59 (.19)	.002	.21-.97
		Negative Mood	-.04 (.02)	.02	-.07- -.01
		Average Consummatory Pleasure	.81 (.08)	.0001	.65-.97
		Group x Average Consummatory Pleasure x Negative Mood.	-.001 (.002)	.43	-.005-.002
		Intercept	.81 (.48)	.10	-.14-1.76
Model 7 (n=389)	Leisure Motivation	Group	-.81 (.60)	.18	-1.98-.36
		Negative Mood	-.15 (.06)	.009	-.26- -.04
		Average Consummatory Pleasure	.61 (.31)	.05	-.002-1.22
		Group x Average Consummatory Pleasure x Negative Mood.	.01 (.01)	.21	-.004-.02
		Intercept	9.75 (2.24)	.0001	5.37-14.14
Model 8 (n=1173)	Functional Motivation	Group	.51 (.47)	.27	-.40-1.43
		Negative Mood	-.11 (.03)	.002	-.18- -.04
		Average Consummatory Pleasure	1.17 (.19)	.0001	.79-1.55

		Group x Average Consummatory Pleasure x Negative Mood.	.003 (.004)	.50	-.01-.01
		Intercept	4.09 (1.15)	.0001	1.83-6.35
Model 9 (n=389)	Leisure Expectation	Group	-.52 (.52)	.32	-1.54-.51
		Negative Mood	-.06 (.04)	.15	-.14-.02
		Average Consummatory Pleasure	.52 (.26)	.05	.01-1.03
		Group x Average Consummatory Pleasure x Negative Mood.	.002 (.004)	.69	-.01-.01
		Intercept	8.98 (1.82)	.0001	5.41-12.56
Model 10 (n=1173)	Functional Expectation	Group	-1.54 (.48)	.001	-2.49- -.60
		Negative Mood	.0009 (.03)	.97	-.05-.05
		Average Consummatory Pleasure	.84 (.21)	.0001	.43-1.24
		Group x Average Consummatory Pleasure x Negative Mood.	-.005 (.003)	.15	-.01-.002
		Intercept	8.80 (1.14)	.0001	6.57-11.04

8.3.4 Is there an Association between Current Context (Mood and Enjoyment) and Anticipatory Pleasure and Expectation?

The models used to estimate the following results are detailed below in Table 26 (Models 11-18). Anticipatory pleasure is associated with consummatory pleasure, positive affect and negative affect for both categories of activity in the schizophrenia group. In the control group consummatory pleasure and positive mood were associated with anticipatory pleasure for functional activities only (see Table 26). Expectation ratings were associated with negative mood in for both activities in the schizophrenia group and positive mood for functional activities only. In the control group positive mood was associated with expectation for leisure activities and anticipatory pleasure for functional activities only.

Table 26: Multi-level models of the association between current mood and enjoyment and anticipatory ratings

Multi-Level Model (n = beeps)	Outcome Variable	Predictors	Beta Coefficient (SD)	P Value	95% Confidence Intervals (p value)
Model 11 SZ Group Leisure (n=45)	Anticipatory Pleasure	Consummatory Pleasure	.70 (.15)	.0001	.41-.99
		Negative Mood	.06 (.02)	.02	.01-.10
		Positive Mood	.11 (.05)	.03	.01-.20
		Intercept	-1.18 (1.29)	.36	-3.71-1.34
Model 12 Control Group Leisure (n=93)	Anticipatory Pleasure	Consummatory Pleasure	.17 (.11)	.11	-.04-.37
		Negative Mood	-.05 (.04)	.18	-.13-.02
		Positive Mood	.03(.03)	.29	-.03-.09
		Intercept	4.54 (.82)	.0001	2.93-6.15
Model 13 SZ Group Functional (n=188)	Anticipatory Pleasure	Consummatory Pleasure	.48 (.06)	.0001	.36-.60
		Negative Mood	-.04(.01)	.001	-.06 -.02
		Positive Mood	.05(.02)	.005	.01-.09
		Intercept	2.58 (.54)	.0001	1.53-3.64
Model 14 Control Group Functional (n=550)	Anticipatory Pleasure	Consummatory Pleasure	.18 (.05)	.0001	.09-.27
		Negative Mood	-.003 (.01)	.81	-.03-.02
		Positive Mood	.08 (.02)	.0001	.05-.11
		Intercept	2.54 (.32)	.0001	1.92-3.16

Model 15 SZ Group Leisure (n=45)	Expectation	Consummatory Pleasure	-.30 (.22)	.18	-.72-.13
		Anticipatory Pleasure	-.05(.17)	.75	-.39-.28
		Negative Mood	-.09(.03)	.005	-.15 -.03
		Positive Mood	-.0003 (.05)	.99	-.10-.10
		Intercept	13.91 (1.61)	.0001	10.75-17.06
Model 16 Control Group Leisure (n=93)	Expectation	Consummatory Pleasure	-.05 (.10)	.66	-.25-.16
		Anticipatory Pleasure	.01 (.09)	.88	-.17-.20
		Negative Mood	-.02 (.04)	.65	-.10-.06
		Positive Mood	.06 (.03)	.04	.001-.12
		Intercept	10.15 (.95)	.0001	8.29-12.02
Model 17 SZ Group Functional (n=188)	Expectation	Consummatory Pleasure	0.13 (.11)	.22	-.35-.08
		Anticipatory Pleasure	.17 (.11)	.12	-.05-.39
		Negative Mood	-.10 (.02)	.0001	-.14- -.06
		Positive Mood	.09 (.03)	.003	.03-.16
		Intercept	9.37 (1.12)	.0001	7.17-11.57
Model 18 Control Group Functional (n=550)	Expectation	Consummatory Pleasure	.05 (.07)	.53	-.10-.19
		Anticipatory Pleasure	.18 (.07)	.008	.05-.32
		Negative Mood	.03 (.02)	.12	-.01-.01
		Positive Mood	.02 (.03)	.48	-.03-.07
		Intercept	9.23 (.57)	.0001	8.12-10.35

8.3.5 Variability of Anticipatory Pleasure, Consummatory Pleasure and Expectation over Time

Variation partition coefficients (VPCs) were calculated using the random effects coefficients for participant, day and beep estimated in the multi-level model. These provide some insight into how much variation in the outcome as predicted by the model occurs at the participant, day and beep levels. The higher the VPC value the more the construct varies at that level e.g. from person-to-person. The coefficients translate directly into percentages e.g. a VPC of .46 is interpreted as 46% of variation in that variable is accounted for at that level. The VPCs reported below (see Table 27) were estimated from Models 11-18 described

above with mood, anticipatory and consummatory pleasure. Constructs which have the highest VPCs at participant level, vary most *between* participants, not days or beeps, and thus are considered relatively stable over time. The factors which have the highest VPCs at participant level in the control group are anticipatory pleasure and expectation for leisure activities. In the schizophrenia group these variables are leisure consummatory pleasure and expectation for both leisure and functional activities. The majority of the variance of the other variables appears to occur between beeps or days suggesting these vary more with the current context of the individual.

Table 27: Variation Partition Coefficients (VPCs) at participant, day and residual levels for each outcome variable in the multi-level linear models estimated

Outcome Variable	HC			SZ		
	Participant VPC	Day VPC	Beep VPC	Participant VPC	Day VPC	Beep VPC
Functional Anticipatory Pleasure	.46	.01	.53	.12	.07	.81
Leisure Anticipatory Pleasure	.96	.00	.04	.28	.17	.55
Functional Consummatory Pleasure	.20	.05	.75	.33	.05	.62
Leisure Consummatory Pleasure	.06	.13	.81	.99	.00	.01
Functional Expectation	.28	.23	.49	.63	.15	.22
Leisure Expectation	.59	.23	.18	.89	.02	.09

8.3.6 Which Anticipatory Constructs Predict Activities Occurring?

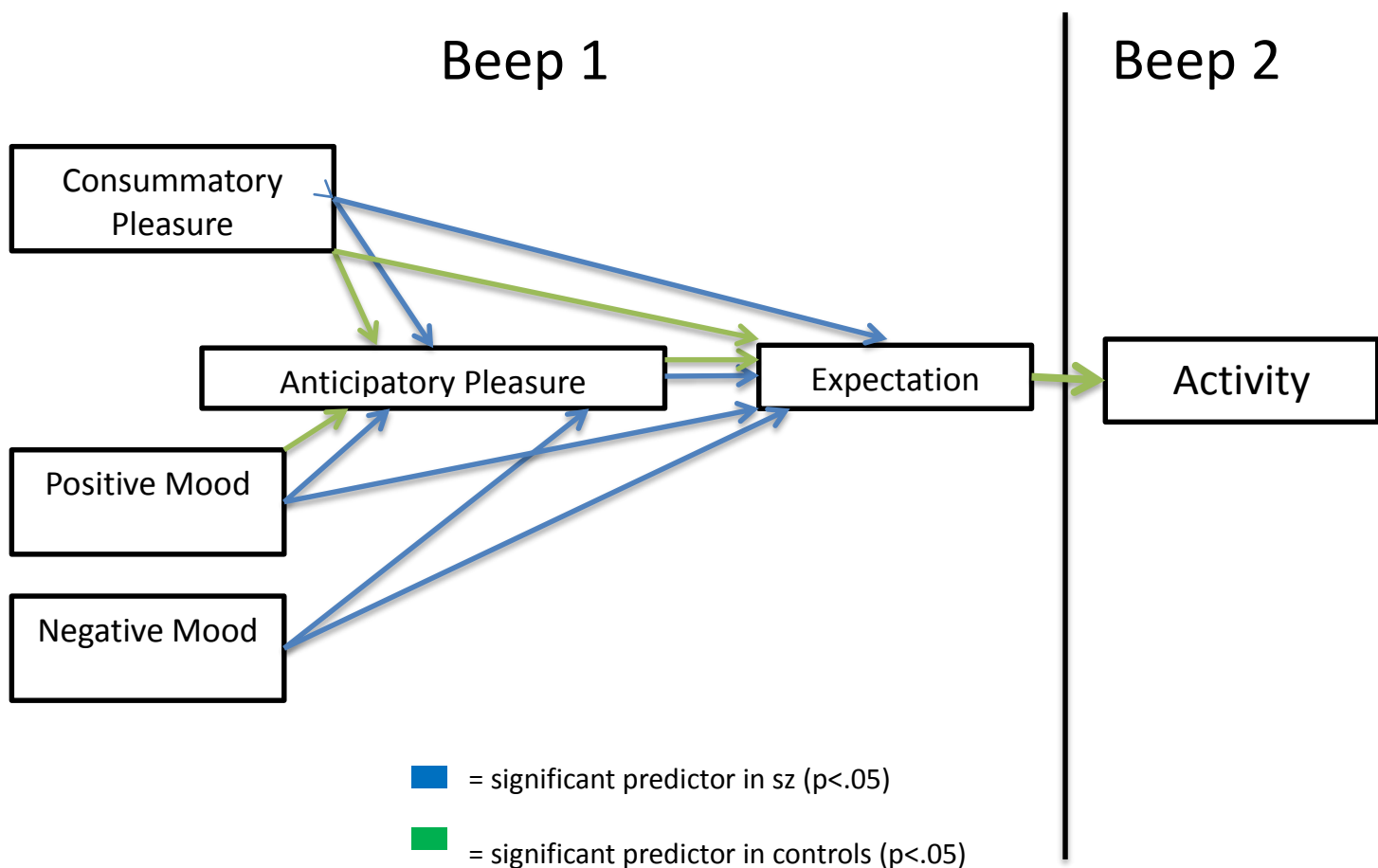
To test the hypothesis from the TEP model that anticipatory pleasure, expectation and motivation drive activity a time-lagged analysis of these variables with activity as the outcome was conducted (see Model 19, Table 28). In the control group, expectation

predicted functional activities ($\beta=.15$, $p=.031$ 95% CI=-.01-.28) occurring at the next time-point (controlling for negative and positive mood). *None* of the time-lagged ratings of anticipatory pleasure, motivation or expectation at a beep predicted the anticipated activity occurring at the next beep in the schizophrenia group. The relationships described above in Models 8-19 are all summarised in Figure 22 below.

Table 28: Multi-level model of time-lagged predictors of future activity

Multi-Level Model	Outcome Variable	Predictors
Model 19 Estimated separately for people with schizophrenia and controls.	Activity (functional and leisure)	Lagged expectation, lagged anticipatory pleasure, lagged motivation, negative mood and positive mood.

Figure 22: A summary diagram of the relationships between variables at the same time-point (Models 7 and 8) and predictors of activity (Model 9)



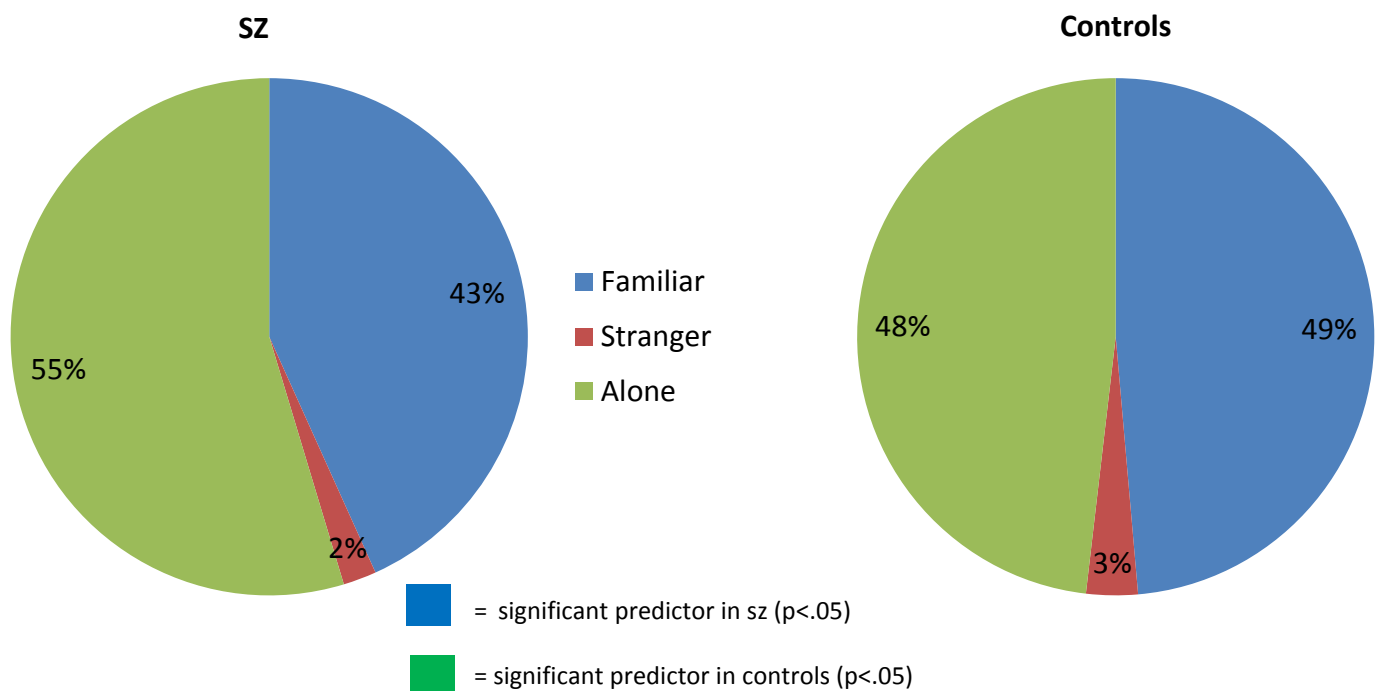
8.3.7 Social Findings

Data regarding social experiences, preferences and enjoyment were also collected using the ESM questionnaire. These were analysed separately from the activity data above to address the hypotheses regarding between-group differences in social activity levels, anticipatory pleasure and consummatory pleasure. Further to these hypotheses this study attempted to replicate the finding that people with schizophrenia report a higher preference to be alone.

8.3.8 Social Activity

People with schizophrenia and controls spend similar amounts of time in both familiar company, unfamiliar company and alone ($F(1,75)=.731, 1.68, 1.15$ respectively, $p=.20-.40$) see Figure 23.

Figure 23: Proportion of beeps occurring when alone, with familiar or unfamiliar company



8.3.9 Between-Group Differences in Social Pleasure and Preferences

There were no significant differences between people with schizophrenia and controls in anticipatory and consummatory pleasure for social activities (Table 29, Models 20-24). People with schizophrenia rated their consummatory pleasure of being alone lower than controls at trend level only (Model 21). People with schizophrenia also rated a higher preference than controls to be with others when alone (Model 26). However, people with schizophrenia did not rate their anticipatory pleasure for being alone as lower than controls and in fact rated their preference to be alone significantly higher (Model 25). Due to the very small number of beeps at which the participants indicated they were in the company of strangers these occasions were not investigated.

Table 29: Multi-level models of between-group differences in social consummatory pleasure, anticipatory pleasure and preference to be alone/with others

Multi-Level Model	Outcome Variable	Predictors	Beta Coefficient (SD)	P Value	95% Confidence Intervals (p value)
Model 20 (n=1094)	Familiar Social Consummatory Pleasure	Group	.12 (.33)	.73	-.53-.76
		Negative Mood	-.11 (.03)	.0001	-.17- -.05
		Group x Negative Mood	.04 (.02)	.03	.003-.07
		Intercept	6.05 (.49)	.0001	5.10-7.01
Model 21 (n=1135)	Alone Consummatory Pleasure	Group	-.78 (.43)	.07	-1.6-.07
		Negative Mood	-.07 (.03)	.04	-.14- -.004
		Group x Negative Mood	.04 (.02)	.02	.007-.08
		Intercept	5.10 (.65)	.0001	3.82-6.36
Model 22 (n=62)	Stranger Social Consummatory Pleasure	Group	.92 (1.04)	.38	-1.12-2.97
		Negative Mood	.004 (.12)	.98	-.24-.24
		Group x Negative Mood	.005 (.08)	.95	-.15-.16
		Intercept	3.17 (1.46)	.03	.30-6.04
Model 23 (n=559)	Familiar Social Anticipatory Pleasure	Group	-.04 (.20)	.86	-.43-.36
		Negative Mood	-.11 (.01)	.0001	-.13--.09
		Consummatory Pleasure	.70 (.08)	.0001	.55-.85
		Group x Negative	.01 (.001)	.0001	.006-.01

		Mood x Consummatory Pleasure			
		Intercept	2.21 (.49)	.0001	1.26-3.17
Model 24 (n=328)	Alone Anticipatory Pleasure	Group	-.15 (.29)	.61	-.71-.41
		Negative Mood	-.09 (.01)	.0001	-.11--.06
		Consummatory Pleasure	.52 (.11)	.0001	.31-.74
		Group x Negative Mood x Consummatory Pleasure	.01 (.001)	.0001	.005-.01
		Intercept	3.13 (.64)	.0001	1.89-4.38
Model 25 (n=1094)	Preference to be Alone	Group	.84 (.23)	.0001	.39-1.29
		Negative Mood	.13 (.01)	.0001	.11-.16
		Consummatory Pleasure	-.40 (.10)	.0001	-.58- -.21
		Group x Consummatory Pleasure x Negative Mood	-.01 (.001)	.001	-.01- -.007
		Intercept	2.67 (.63)	.0001	1.44-3.90
Model 26 (n=1135)	Preference to be with Others	Group	5.62 (.47)	.0001	4.69-6.54
		Negative Mood	-.04 (.01)	.01	-.06- -.01
		Consummatory Pleasure	-.52 (.16)	.001	-.83- -.21
		Group x Consummatory Pleasure x Negative Mood	-.001 (.001)	.44	-.003-.001
		Intercept	4.96 (.61)	.0001	3.78-6.15

8.3.10 Association between Current Context (Mood and Pleasure) and Social Anticipatory Pleasure

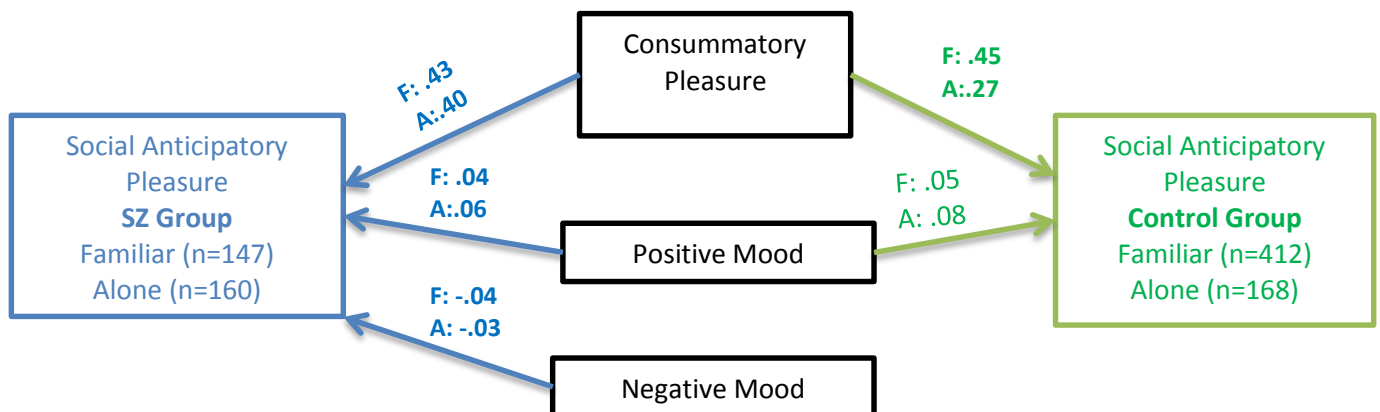
Analyses were conducted to attempt to extend the findings regarding the association between context and anticipation from the non-social data to the social data.

In the schizophrenia group social anticipatory pleasure both for being alone and with familiar people was significantly predicted by consummatory pleasure (familiar: $\beta=.43$,

$p=.0001$ 95% CI: .29-.56; alone: $\beta=.43$, $p=.0001$ 95% CI: .28-.52), positive mood (familiar: $\beta=.04$, $p=.05$ 95% CI: .00-.08; alone: $\beta=.06$, $p=.02$ 95% CI: .01-.10) and negative mood (familiar: $\beta=-.04$, $p=.002$ 95% CI: -.07- -.01; alone: $\beta=-.03$, $p=.03$ 95% CI: -.06- -.002) (see Figure 24).

In the control group social anticipatory pleasure was predicted by consummatory pleasure (familiar: $\beta=.45$, $p=.0001$ 95% CI: .37-.53; alone: $\beta=.27$ $p=.0001$ 95% CI: .17-.37) and positive mood (familiar: $\beta=.05$, $p=.001$ 95% CI: .02-.08; alone: $\beta=.08$ $p=.001$ 95% CI: .03-.17).

Figure 24: Influence of context on social anticipatory pleasure for being alone or with familiar people at the same time-point in people with schizophrenia and controls ($p<.05$). F= Familiar β coefficient, A= Alone β coefficient



8.3.11 What Predicts Future Social Activity?

A model was estimated using time-lagged variables to predict socialising or being alone at the next time-point. None of the time-lagged variables- anticipatory pleasure, consummatory pleasure or preference to be alone/with others predicted socialising with familiar people or being alone at the next time-point in either group.

8.3.12 Are Consummatory Pleasure, Anticipatory Pleasure, Motivation or Expectation Associated with Experiential Negative Symptoms?

The CAINS experiential subscale inversely correlated significantly or at trend level with almost all of the ESM anticipatory ratings with the exception of expectation for functional activities and anticipatory pleasure for leisure activities (see Table 30). However,

in contrast to the hypothesis the CAINS experiential subscale also correlated with consummatory pleasure ratings.

The PANSS disorganised subscale positively correlated with motivation but only at trend level. The PANSS depressed scale only negatively correlated at trend level with expectation for functional activities. The PANSS negative subscale scores did not correlate with any ESM ratings.

Table 30: Correlation matrix between interview symptom measures (PANSS and CAINS) and ESM ratings of consummatory pleasure, anticipatory pleasure, expectation and motivation

		CAINS experiential	PANSS disorganised	PANSS depressed	PANSS negative
Functional Activities	Expectation	-.31	-.26	-.32*	-.21
	Motivation	-.34*	.30	-.09	-.14
	Anticipatory Pleasure	-.35*	.32	-.10	-.19
	Consummatory Pleasure	-.42**	.22	-.18	-.12
Leisure Activities	Expectation	-.45**	-.09	-.07	.01
	Motivation	-.46**	.35*	-.19	-.03
	Anticipatory Pleasure	-.14	-.13	.04	.16
	Consummatory Pleasure	-.34**	.28	-.17	.08

*=trend at $p < .1$, **=significant at $p < .05$.

8.4 Discussion

The aim of this study was to investigate support for the pathway from anticipatory pleasure to activity proposed in the TEP model and how this applies to everyday life. A secondary aim was to examine the influence of context, specifically mood and current pleasure on anticipation.

8.4.1 Are There Between-Group Differences in the Constructs from the TEP Model?

The findings from the experience sampling study showed that in contrast to the anticipatory pleasure deficit hypothesis in the TEP model, anticipatory pleasure for both leisure and functional activities was significantly higher in people with schizophrenia, replicating findings from two previous studies (Brenner & Ben-Zeev, 2014; Gard, Sanchez, Cooper, et al., 2014). Consummatory pleasure was also found to be higher in the schizophrenia group, in contrast to a previous experience sampling study which reported no difference compared to controls, although this PhD work has a much larger sample size (Gard et al., 2007). These elevated pleasure ratings did not translate into greater levels of activity or increased motivation to engage in these activities. Everyday functioning was impaired in people with schizophrenia who report completing fewer functional activities and more time spent “doing nothing” than controls. Expectation that the anticipated activities will occur was decreased for functional activities in people with schizophrenia and was no different to controls for leisure activities. These between-group differences tell a story of a disconnection between pleasure ratings and those factors which are hypothesised to follow in the TEP model - expectation, motivation and activity. Negative mood was found to be elevated in people with schizophrenia, replicating a common finding in experience sampling studies (Sanchez et al., 2014).

8.4.2 Associations with Current Context

The results showed current emotional context, specifically positive mood, negative mood and enjoyment to be associated more often with anticipatory pleasure and

expectation ratings in people with schizophrenia compared to controls. Context bias has been investigated in affective forecasting studies with controls which have demonstrated that people are influenced by their current mood and recent enjoyment of activities when providing anticipatory ratings (Gilbert & Wilson, 2007). These findings argue that the predictions of the TEP model should incorporate the influence of current context, specifically mood and recent enjoyment of a similar activity, particularly as this appears to have a significantly stronger association with anticipation in the schizophrenia group. The finding that current context is associated with pleasure replicates findings from studies which used ESM to examine the role of context in the experience of positive symptoms i.e. hallucinations and delusions. These studies have reported that changes in mood predict the occurrence of positive symptoms but also the duration of the episode and distress experienced by the individual (Ben-Zeev, Ellington, Swendsen, & Granholm, 2011; Thewissen et al., 2011; Udachina, Varese, Oorschot, Myin-Germeys, & Bentall, 2012).

The findings from this study suggest that people with schizophrenia may be more susceptible to the context bias factors such as mood and current pleasure than controls. This could be due to cognitive difficulties in areas such as executive functions which are involved in selecting relevant information to make decisions. It has been shown that poorer executive functions in people with schizophrenia can lead to difficulties selecting the correct information to incorporate in decision making in both social, and non-social tasks (Luck & Gold, 2008; Tully, Lincoln, & Hooker, 2012). It may be that this difficulty with input selection could lead to impairment in discounting current context factors such as mood and enjoyment when anticipating future events in the schizophrenia group. Cognitive flexibility is also needed to disengage from current mood states and this has also been shown to be reduced in people with schizophrenia, particularly those with severe negative symptoms (Rethelyi et al., 2012).

The VPCs were mixed with some ratings (expectation and anticipatory pleasure) appearing stable over time in the schizophrenia group perhaps suggesting they reflect held beliefs rather than being sensitive to information about the activity they are anticipating. The stability of these ratings in each individual may also reflect the consistency of contextual factors in their environment. Other ratings, including consummatory pleasure, were variable over time, both between days and beeps. This is perhaps unsurprising as the findings from

the COP task also showed more variability in consummatory pleasure ratings compared to anticipatory ratings in both groups. It seems from both these studies that people do not anticipate as wide a range of emotions as they report “in the moment”.

8.4.3 Predictors of Activity

The disparity between anticipation and activity becomes apparent when examining predictors of activity in both groups, only expectation predicted activity occurring and this link was only seen in the control group. This conclusion is limited as the questionnaire may miss the anticipated activity due to the random timing of the beeps.

Expectation is the cognitive understanding that the activity being anticipated will occur in the future. The TEP model hypothesises that this is the cognitive component of anticipation and the feeling of anticipatory pleasure is generated on the basis of this expectation. This study asked individuals to rate the likelihood of the event they anticipated occurring in the future - and this implicates several related constructs where there might be a difficulty: high negative mood, planning ability, defeatist beliefs, lack of opportunity which are all absent from the TEP model.

The findings from this study support the close association of expectation and anticipatory pleasure as proposed in the TEP model. The pathway from anticipatory pleasure to activity proposed in the TEP model has received support in these findings in the control group only. Instead of the anticipatory pleasure deficit hypothesis proposed initially, this study suggests that the difficulty in schizophrenia is in completing the pathway proposed in the model and using anticipation to drive activity rather than a deficit in any of the components individually. This is further explored in Chapter 10 but represents an important avenue for future research.

8.4.4 Disparity in the Social-Specific Findings

In contrast to the hypothesis but replicating a previous finding (Janssens et al., 2012) people with schizophrenia spent a similar proportion of their time with other people. Also in contrast to the hypothesis there was no difference in social anticipatory or consummatory

pleasure in people with schizophrenia compared to controls. However, there were also disparate findings between anticipation and activity in the social component of the study. Enjoyment of being alone was lower at trend level in the schizophrenia group and yet these individuals rated their preference for being alone as significantly higher when with other people. This higher preference for being alone is a replication of a previous finding, but has not been previously reported in the context of reduced enjoyment of being alone (Oorschot et al., 2013). People with schizophrenia also reported a higher preference to be with others when they were alone compared to controls, but this did not translate into more time spent with others overall. Similarly to the non-social anticipatory ratings current context factors (pleasure and mood) were more often associated with social anticipatory pleasure in people with schizophrenia compared to controls. None of these ratings (social pleasure or preferences) then predicted socialising or being alone at the next time-point in either group suggesting different factors may drive social behaviour. These could include reduced social capital, difficulty travelling or poverty (Kirkbride et al., 2008). The activity ratings highlighted expectation as an important predictor of activity and this is not measured for the social activities. This is a limitation of the study and the role of expectation in engagement in future social activities should be a priority for further research.

8.4.5 Are Anticipatory, not Consummatory, Constructs from the TEP Model Associated with Experiential Negative Symptoms?

The evidence that supported this hypothesis came almost entirely from analyses including the CAINS experiential subscale which significantly correlated with the majority of ESM anticipatory pleasure and motivation ratings. However, it did also correlate with consummatory pleasure ratings suggesting, in contrast to the TEP model, that this is also related to experiential negative symptoms reported by participants. In contrast to this, the specific negative symptom factors of the PANSS showed very weak or absent relationships with everyday life measures of pleasure and motivation. Overall, the current findings offer limited support for the proposal in the TEP model that self-report experiential negative symptom measures reflect the specific process of anticipatory pleasure.

This difference in the relationships with the two negative symptom measures (CAINS and PANSS) is probably due to their differing focus on experiential negative symptoms

including motivation and pleasure which are the ratings given during the ESM week (Garcia-Portilla et al., 2015). The CAINS is a much more accurate measure of this experiential vs. expressive distinction in negative symptoms as it was developed with this purpose and has been well-validated (C. Forbes et al., 2010; Horan et al., 2011; Kring et al., 2013; Malaspina et al., 2014; S. G. Park et al., 2012). The current findings strongly support the validity of the CAINS as an assessment of the experience of pleasure in everyday life. Alongside the extensive validation studies (C. Forbes et al., 2010; Horan et al., 2011; Kring et al., 2013) this recommends the CAINS should be prioritised for use over the PANSS in studies assessing negative symptoms.

8.4.6 Summary

This study investigated the components of the TEP model in the everyday life context. The findings support a deficit in expectation in the schizophrenia group but not in anticipatory pleasure or motivation. This study showed that expectation is important in driving future activity in controls, above and beyond anticipatory pleasure and motivation. A consistent finding across all the ratings was a disconnection between anticipatory ratings and actual activity- both in the social and non-social contexts. There appears to be a deficit in translating anticipation into activity; the nature of this deficit is important to understand in order to drive research towards effective therapeutic targets.

Chapter 9: To What Extent do the Three Methodologies Assess the Same Constructs?

9.1 Introduction

It is rare for studies to conduct self-report measures, experience sampling and experimental tasks with the same individuals in the field of schizophrenia research. Each paradigm has different strengths and can also compensate for the weaknesses of the others. For example, ESM has high ecological validity as it is conducted in everyday life but each individual may experience different environments that bias their reports and are difficult to record and control for. An experimental approach, however, ensures that all individuals experience the same stimuli and environment during their participation in the study. Self-report using hypothetical scenarios, as in the TEPS, also standardises the stimuli that participants are responding to but may be limited in its assessment of consummatory pleasure in particular, due to the abstract nature of the stimuli. The inclusion of all three methods maximises the validity of generalising the findings across different individuals.

The three methods also allowed the assessment of the experience of pleasure and motivation at different levels of specificity. The TEPS provided an overview of the experiences of that person. The ESM study presented findings relating to more specific constructs such as “anticipatory pleasure related to a leisure activity” which are measured more often, in this case 7 times a day for 6 days. These results provided a more detailed picture than the TEPS and contributed to the identification of difficulties in everyday life. Finally, the experimental approach, in this case the COP task, assessed very specific constructs such as anticipatory pleasure in much more detail than either of the previous methodologies. This study used multiple stimuli to thoroughly assess the experience of pleasure in response to a wide range of stimuli selected by the experimenter and presented to every participant. The protocol of the COP task also tailored the stimuli selected to the individual’s preferences, minimising the impact of any bias present due to idiosyncratic preferences.

The independent value of each of these approaches has been discussed in previous chapters and many previous studies have utilised one or two of these methods (see Chapters 1 and 2). The findings from the previous chapters in this thesis suggest there may be some degree of convergence in the measurement of pleasure, as all three methods have revealed a specific association between anticipatory pleasure and positive affect. Furthermore, convergent validity analyses conducted in Chapter 5 revealed an association between anticipatory and consummatory COP task ratings and the corresponding TEPS subscales, although only with non-social and low pleasantness stimuli. It is currently unclear how ratings from these methods relate to ESM ratings and in order to draw conclusions from across the different methodologies it is important to establish to what extent they are measuring the same constructs. ESM provides the most accurate data regarding the everyday experience of individuals and was therefore considered a “gold-standard” in the assessment of constructs in this context (Kimhy et al., 2012). It was therefore also important to establish how the TEPS and COP task compare to this “gold-standard” measure of everyday life experiences of anticipatory and consummatory pleasure.

The TEPS is based on the anticipatory and consummatory pleasure distinction proposed in the TEP model (Gard et al., 2006; Kring & Caponigro, 2010). As discussed previously, the potential limitations of using self-report, particularly to assess consummatory pleasure, are a current debate in the literature. To contribute to this debate, this chapter assessed whether this measure examined similar constructs to anticipatory and consummatory pleasure in everyday life. This could provide some degree of external validation for the subscales included in the TEPS (Oorschot et al., 2009). This analysis was repeated to examine the relationship between COP task ratings and ESM ratings to assess the extent to which the ratings from the laboratory environment relate to everyday life. Those measures which are related to everyday life could be recommended for use in future research on the basis of this finding. This process of identifying measures which should be prioritised in future research reflects the emphasis placed on the development of psychological interventions which target functional outcomes in the field (P. D. Harvey, 2009).

The relationships between the TEPS and COP task measurements of anticipatory and consummatory pleasure were analysed in Chapter 5 and found to be present but non-

specific i.e. TEPS anticipatory pleasure was associated with both COP task consummatory and anticipatory subscales and vice versa. Across several previous chapters, mood and specifically positive affect has been shown to be related to anticipatory and consummatory pleasure. The focus of this chapter was therefore on the relationships between both these measures and the “gold-standard” of experience sampling, as well as the potential moderating role of mood. The hypotheses were as follows:

- (i) The TEPS ratings of anticipatory and consummatory pleasure are related to the same constructs measured using experience sampling methodology.
- (ii) The COP task ratings of anticipatory and consummatory pleasure are related to the same constructs measured using experience sampling methodology.

9.2 Method

9.2.1 Sample

The participants recruited for this study were the same as those who took part in the experience sampling study described in Chapters 7 and 8. The inclusion/exclusion criteria for this sample are described in more detail in Chapter 3.

9.2.2 Measures

Full details of all the measures included in the study and the items included are described in Chapter 3, Pages 113-117.

This study used the following measures:

- Mini International Neuropsychiatric Interview (MINI) (Sheehan et al., 1998).
- Temporal Experience of Pleasure Scale (TEPS).
- Components of Pleasure (COP) Task.
- Experience Sampling Questionnaire.

9.2.3 Analyses

9.2.3.1 Data Quality

Multi-level models were not appropriate analyses to conduct in this study as the TEPS and COP task were only conducted at one time point and this violates the repeated measures assumption in these models. The averages were therefore taken from the ESM data (see Chapter 8, Table 23) for use in these analyses. Outliers were identified as those values ± 2 standard deviations from the mean within each group and analyses were conducted with these participants included and excluded (see Chapter 3, Page 120). As discussed in Chapter 3, the Benjamini & Hochberg False Discovery Rate (Benjamini & Hochberg, 1995) was applied to control for multiple correlations (Chapter 3, Page 120).

9.2.3.2 Relationship between ESM, TEPS and COP Task Ratings: To what extent are they measuring the same constructs?

Pearson correlational analyses were conducted between the ratings from each methodology to assess the degree to which the ratings of anticipatory and consummatory pleasure measure the same constructs. In the analysis of ESM and COP task ratings social and non-social items were analysed separately so that social content did not introduce any bias into the associations that may be present as suggested in previous research (Bodapati & Herbener, 2014). The TEPS does not contain any social items so this was analysed with non-social ESM ratings only. All correlational analyses were repeated controlling for ESM positive affect in partial correlations as positive affect has been shown to be related to the ratings in all three paradigms and ESM provides the most data on the nature of the person's current mood.

9.3 Results

The final sample is detailed in Chapter 7 (Page 171) and included 33 people in the schizophrenia group and 43 people in the control group.

9.3.1 To What Extent are Anticipatory and Consummatory TEPS Subscales and ESM Anticipatory and Consummatory Ratings Measuring the Same Constructs?

The TEPS anticipatory and consummatory subscales did not correlate with the corresponding ESM ratings in either group (Table 31). In the control group, the TEPS consummatory subscale had a moderate correlation with ESM anticipatory pleasure, whilst the TEPS anticipatory subscale had a moderate correlation with ESM consummatory pleasure. Partial correlations controlling for positive mood during the ESM week were conducted and the conclusions were not altered. However, the Pearson's coefficients of the significant findings were reduced ($r=.30$).

Table 31: Correlation matrix of TEPS and ESM anticipatory and consummatory ratings

		HC		SZ	
		TEPS Ant	TEPS Con	TEPS Ant	TEPS Con
Experience Sampling Variables	Functional Anticipatory Pleasure	.27	.34*	.18	.03
	Leisure Anticipatory Pleasure	.03	-.08	.21	.20
	Functional Consummatory Pleasure	.34*	.22	.04	-.04
	Leisure Consummatory Pleasure	.24	.16	-.05	-.13

*= $p<.05$

9.3.2 To What Extent are Non-Social Anticipatory and Consummatory COP Task Ratings and ESM Non-Social Ratings Measuring the Same Constructs?

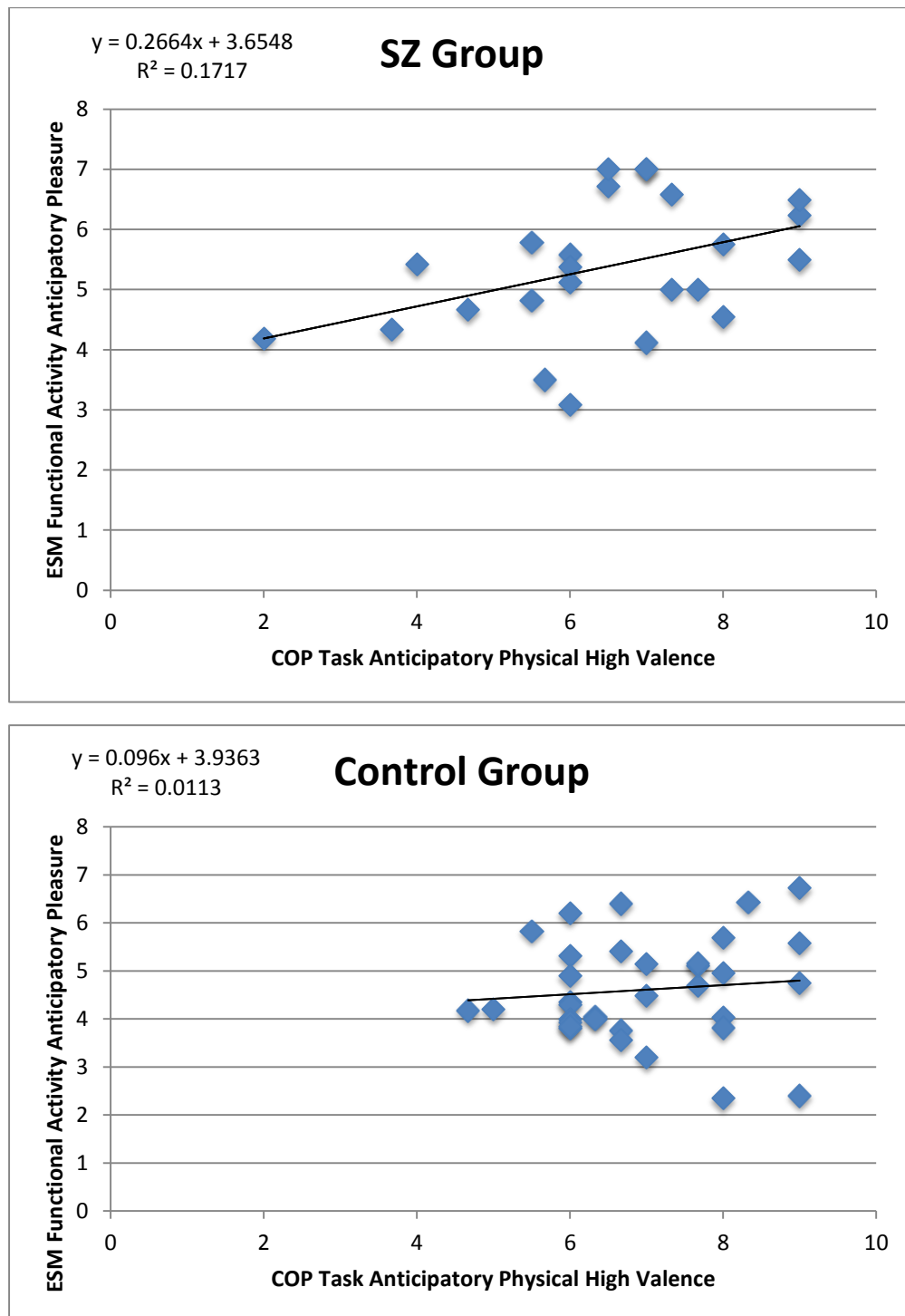
9.3.2.1 Consummatory Pleasure

There was no association between ESM functional (HC: $r = -.06$, $p = .70$, SZ: $r = -.10$, $p = .58$) or ESM leisure consummatory ratings (HC: $r = -.24$, $p = .15$) and non-social consummatory COP task ratings in either group. However, partial correlations controlling for ESM positive affect revealed an association between ESM leisure consummatory pleasure and COP task non-social consummatory ratings in the control group ($r = .38$, $p = .04$).

9.3.2.2 Anticipatory Pleasure

In the schizophrenia group anticipatory pleasure ratings of *highly pleasant* non-social pictures were associated with anticipatory pleasure for functional ($r = .41$, $p = .05$) and leisure ($r = .45$, $p = .04$) activities in everyday life. There was only an association at trend level between *highly pleasant* non-social anticipatory ratings on the COP task and anticipatory pleasure for functional activities in the control group ($r = .35$, $p = .06$) (see Figure 25). However, all these relationships become non-significant when partial correlations controlling for ESM positive affect are conducted ($r = -.08$ -. $.22$, $p > .10$). The COP task anticipatory ratings of images rated as *low pleasantness* by the participants were not associated with ESM anticipatory ratings in either group (HC leisure $r = -.07$, functional $r = -.08$, $p > .10$; SZ leisure $r = -.003$, functional $r = .08$, $p > .10$). These findings were not altered significantly when ESM positive affect was controlled for in partial correlations.

Figure 25: Scatterplots of mean COP task and ESM functional anticipatory ratings with a regression line fitted in both groups



9.3.3 To What Extent do the *Social* Anticipatory and Consummatory COP Task Ratings Measure the Same Constructs as the Social ESM Ratings?

9.3.3.1 Consummatory Pleasure

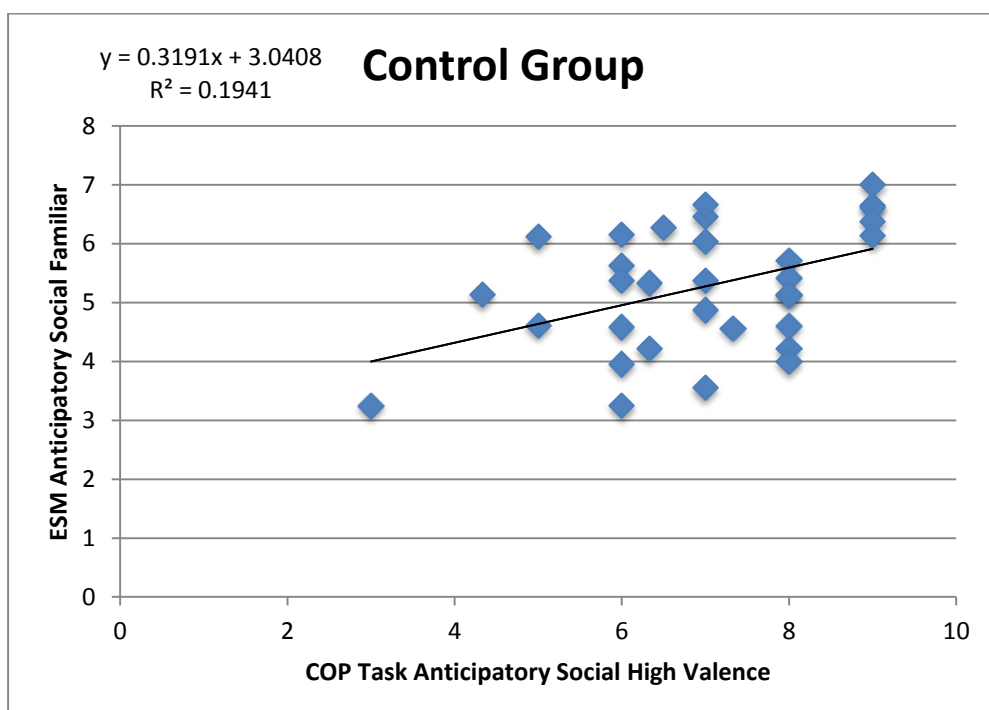
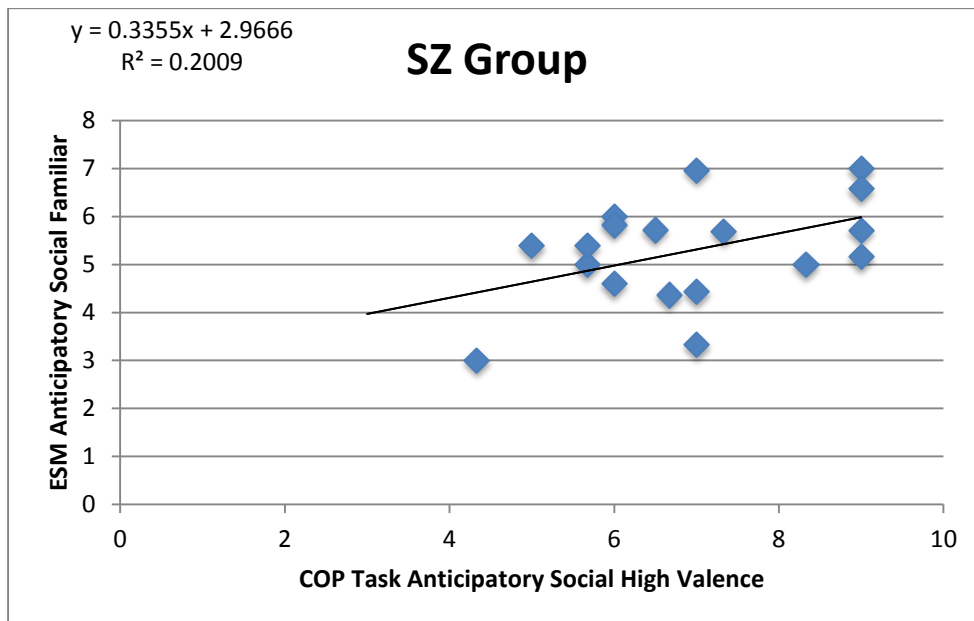
COP task social consummatory pleasure ratings were not associated with ESM social consummatory pleasure ratings for “being with others” (HC $r = .19$, $p = .21$; SZ $r = .14$, $p = .47$) or alone (HC $r = -.11$, $p = .48$; SZ $r = -.18$, $p = .33$) in either group. These findings were not altered by controlling for ESM positive affect.

9.3.3.2 Anticipatory Pleasure

In the control group, COP task anticipatory ratings for *highly pleasant* social stimuli were positively associated with ESM anticipatory pleasure for being with family and friends in everyday life ($r = .44$, $p = .01$). This relationship is strengthened when controlling for ESM positive affect ($r = .49$, $p = .02$). This relationship was present at trend level only in the schizophrenia group ($r = .45$, $p = .06$), and becomes non-significant when controlling for ESM positive affect ($r = .40$, $p = .29$) (see Figure 26). There were no relationships between ESM ratings of being alone and highly pleasant stimuli in either group, this did not change when controlling for ESM positive affect.

In the control group there was a trend level association between ESM anticipatory pleasure for being in familiar company and COP task anticipatory ratings for *low pleasantness* social stimuli ($r = .37$, $p = .06$). The strength of this relationship is increased when controlling for positive affect ($r = .43$, $p = .06$). This relationship was not present when anticipating being alone in either group (HC: $r = -.12$, $p = .55$, SZ: $r = -.16$, $p = .53$). These findings were not altered when ESM positive affect was controlled for.

Figure 26: Scatterplots of mean ESM and COP task anticipatory social ratings with a regression line fitted



9.4 Discussion

This is the first study to assess emotional deficits in people with schizophrenia using an experimental task, experience sampling methodology and self-report symptom measures. This combined approach allowed the consensus between these three measures to be assessed; see Table 32 for a summary of these relationships once positive affect has been controlled for.

Table 32: A graphical representation of the identified associations between the three paradigms

	COP Task Non-Social Ant	COP Task Non- Social Con	COP Task Social Ant	COP Task Social Con	TEPS Ant	TEPS Con
ESM Leisure Ant						
ESM Functional Ant						
ESM Leisure Con						
ESM Functional Con						
ESM Social Familiar Ant						
ESM Social Alone Ant						
ESM Social Familiar Con						
ESM Social Alone Con						
TEPS Ant						
TEPS Con						

■ = significant association in people with schizophrenia.

■ = significant association in controls.

□ = relationship not tested.

■ = non-significant association.

9.4.1 TEPS and ESM Ratings of Anticipatory and Consummatory Pleasure

The TEPS subscales did not correlate with the corresponding ratings given in everyday life. The ESM ratings were therefore unable to support the external validity of the TEPS subscales. In the control group, the opposite of the expected pattern was seen as TEPS anticipatory pleasure correlated with ESM consummatory pleasure and vice versa. These findings were not altered when positive affect was controlled for, although the reduction in the strength of the relationships suggests mood may play a small moderating role in this association. The findings suggest the scales are measuring related constructs but perhaps the specificity of the TEPS subscales is limited. This may be due to the use of hypothetical, abstract scenarios rather than current experiences to assess consummatory pleasure which may also utilise some anticipatory processes such as imagining the situation. These hypothetical scenarios utilised in the TEPS may also be susceptible to the bias introduced by idiosyncratic preferences which were not controlled for in this measure. Furthermore the anticipatory ratings refer to upcoming events such as holidays, rollercoasters and eating out which again may be difficult for people with schizophrenia to access due to reasons such as poverty and lack of opportunity. ESM, on the other hand, only accesses scenarios in the individual's everyday life and this may explain the divergence of the ratings provided in these two methodologies. The findings suggest that the TEPS needs further development to increase its relevance to everyday life experiences.

9.4.2 COP Task and ESM Ratings of Anticipatory and Consummatory Pleasure

The findings of the study showed that the consummatory non-social and social ratings in the COP task were not associated with the non-social or social consummatory ratings in everyday life in either group. It may be that the differing experiences of rating a single image compared with the complexities of an experience in everyday life overwhelm the similarities in the process of rating current enjoyment and result in this divergence. The non-social images in the COP task depicted scenes such as landscape views, food and flowers which differ quite substantially from the experiences individuals are presented with in everyday life. Indeed, real-life experiences are rich and complex which is difficult to fully replicate using images alone. Similarly, rating the enjoyment of actually being with

somebody familiar is a different experience to rating the pleasantness of an image depicting strangers. It is important to note that controlling for positive affect did reveal a relationship with consummatory pleasure during leisure activities and the COP task ratings of non-social consummatory pleasure in the control group. This again highlights the importance of accounting for positive mood in studies investigating the experience of pleasure.

The anticipatory ratings told a different story; in both groups the COP task anticipatory pleasure ratings for highly pleasant non-social and social stimuli were associated with the anticipatory ratings in everyday life. However, these relationships appear to be moderated by positive mood as they were no longer significant once this was controlled for. Anticipatory pleasure may be more susceptible to the influence of mood across methodologies as the stimuli are not present when the ratings are given and a more general representation of the anticipated event may be used (Gilbert & Wilson, 2007). This supports the hypotheses proposed by the Accessibility Model (Robinson & Clore, 2002) and the context bias (Wilson & Gilbert, 2005) discussed in the affective forecasting literature. These authors suggest that anticipation is influenced by factors such as heuristics and biases which are less variable than the “in the moment” experience of pleasure itself resulting in more consistent anticipatory pleasure compared to consummatory pleasure. Context bias refers to the influence of current mood, enjoyment and environment on anticipation (Wilson & Gilbert, 2005). The findings from this study when controlling for positive mood suggest that this external factor does influence the experience of anticipating. The accessibility model proposes that consistently held beliefs about the experience are incorporated into the process of anticipation e.g. “I always enjoy my birthday” or “going to the gym is always difficult” (Robinson & Clore, 2002).

These findings provide initial validation for the use of the COP task to measure anticipatory pleasure. In particular they highlight the importance of tailoring the images to the individuals’ preferences as the association between anticipatory COP task ratings and those in everyday life was stronger with images that individuals rated as highly pleasant. It is also worth noting that the highly pleasant and social anticipatory ratings which showed the strongest relationship to everyday life did not correlate with scores on the TEPS self-report suggesting these pleasure ratings are not captured using that measure. This may also explain why the TEPS does not relate to ESM ratings; it does not appear to measure these

highly pleasant responses and does not contain social items. The moderate size of the correlations suggests that despite the clear differences between the two methodologies the ratings provided are related to each other. This recommends the use of these methodologies in combination to gain a full picture of the experience of pleasure as in this study. As the gold-standard assessment, ESM should be prioritised in future research above the self-report measure and experimental paradigm examined in this study.

9.4.4 Summary

In conclusion there is preliminary support for the validity of the COP task in the assessment of anticipatory and consummatory pleasure, once mood is accounted for. The findings offer only limited support for the use of the TEPS subscales to measure anticipatory and consummatory pleasure but the TEPS does appear less susceptible to the effect of mood. The findings suggest that the TEPS subscales need higher specificity and further development to increase their relevance to everyday life.

Chapter 10: Discussion

10.1 Overall Aims

The aim of this thesis was to test the hypotheses proposed by the Temporal Experience of Pleasure model. This is the most prominent hypothesis in the field and posits an anticipatory pleasure deficit in people with schizophrenia. A systematic review was performed to provide recommendations for future research and highlight promising methods to be utilised in studies examining the experience of pleasure. Three different methods were used to examine the proposed anticipatory pleasure deficit in people with schizophrenia compared to controls. By examining these constructs in depth this thesis contributed to the field by providing clarification of mixed findings in the literature and identifying potential therapeutic targets for the development of interventions.

10.2 Summary of the Systematic Review and Rationale

The systematic review conducted (Chapter 2) reported mixed support for the Temporal Experience of Pleasure model. There were consistent findings regarding an emotional memory deficit and abnormal value and effort computation. However, inconsistencies appear in the field when researchers attempt to identify associations between anhedonia and constructs such as emotional memory, executive functions and working memory which are proposed to contribute to anticipatory pleasure. The lack of a consistent relationship between these constructs and experiential negative symptoms has limited the development of targeted interventions for these difficulties. The conclusion drawn from this review was that the current measures of negative symptoms have limited validity and specificity for anticipatory pleasure. This was the rationale for examining an existing measure of anticipatory pleasure - the TEPS - and developing two new measures to overcome limitations in the field: the COP task and experience sampling.

10.3 Summary of Findings

10.3.1 Temporal Experience of Pleasure Scale

The TEPS was included as it was the only validated self-report assessment of anticipatory and consummatory pleasure (Gard et al., 2006). The hypothetical or abstract scenarios used to generate anticipatory and consummatory ratings in this questionnaire provide a different perspective to the self-report responses on the ESM questionnaire relating to everyday life events. Indeed, the anticipatory and consummatory ratings from the two measures were not associated with each other, perhaps reflecting this differing approach to self-report (Chapter 9). In contrast, the TEPS subscales did correlate with COP task ratings, although only with physical and low pleasantness stimuli so this was not a comprehensive association across all the COP task ratings (Chapter 5). This may reflect the nature of the physical images on the COP task which are more similar to items on the TEPS subscales (e.g. beautiful scenery, food) than the everyday life events assessed in the ESM study. The conclusion drawn from these analyses was that the TEPS subscales require further development to increase their relevance to everyday life but have some convergent validity as a more “abstract” measure of these constructs.

The findings from the affective forecasting literature suggest that the wider context of the individual is related to the anticipation of future events in controls, even when this association may result in over- or under-estimation of future pleasure (Wilson & Gilbert, 2005). This association was tested in the schizophrenia group using the TEPS, and a strong relationship was identified between anticipatory pleasure and positive affect. This was not present in the control group; although this is in contrast to the previous findings, it may suggest that people with schizophrenia distinguish less between their current mood and future pleasure. The wider context was also examined using measures of negative symptoms and functioning and no relationship with self-reported anticipatory and consummatory pleasure was identified once positive mood was controlled for. Indeed this is in contrast to previous studies which have reported associations between TEPS anticipatory and consummatory pleasure and negative symptoms, but not functioning (Chan et al., 2012; Li et al., 2015; Mote et al., 2014). The conclusion from these analyses was that current

positive mood is an important contextual factor in anticipation which is not incorporated into the TEP model and should be examined further in research examining the experience of anticipation.

10.3.2 COP Task

The COP task was developed to overcome the limitations of previous studies by including ratings of both anticipatory and consummatory pleasure in response to the same images. This was possible due to the introduction of an associative learning paradigm which associated the image with a shape enabling participants to rate their anticipatory pleasure in response to a cue. The COP task allowed a direct comparison between anticipatory and consummatory pleasure to be conducted in people with schizophrenia and a control group. This is a direct test of the hypothesis of the TEP model that there is a specific anticipatory pleasure deficit in people with schizophrenia.

The COP task has been shown to be a reliable and valid assessment of anticipatory and consummatory pleasure. Several features of the task controlled for difficulties in learning and memory in the schizophrenia group and the cognitive load was minimised through piloting. The ratings showed good test-retest reliability in both groups. There was some convergent validity demonstrated with the Temporal Experience of Pleasure Scale (TEPS), a self-report measure of anticipatory and consummatory pleasure. This suggests the two measures are assessing similar constructs but with the expected level of divergence from two different methodologies. This finding was then replicated in the comparison of the COP task ratings and those from the ESM study. There was significant divergence in the consummatory ratings between these two methodologies. This suggests the COP task may have limited generalisability to everyday life when used to assess “in the moment” pleasure. In the anticipatory phase however, the COP task and ESM ratings showed moderate correlations, which became non-significant when positive mood was controlled for. This is further support for the consideration of positive affect in studies assessing the experience of pleasure and suggests anticipatory pleasure may be particularly susceptible to the influence of mood as proposed in the descriptions of context bias (Wilson & Gilbert, 2005).

Findings reported in other experimental tasks assessing consummatory pleasure were replicated with no difference between the COP task consummatory ratings of people with schizophrenia and controls (Cohen & Minor, 2010; Herbener et al., 2008; Yan et al., 2012). One novel aspect of this task was the inclusion of separate physical and social images and this revealed a preference towards physical images in the control group. The anticipatory ratings showed no differences between groups which replicated findings from two previous studies (Choi et al., 2013; Trémeau et al., 2010). This was in contrast to the initial hypothesis that anticipatory pleasure would be reduced in people with schizophrenia compared to controls. Another novel aspect of this task was that the images selected for the anticipatory phase were tailored to each individual's preferences. The anticipatory and consummatory ratings of the exact same images were compared to calculate a discrepancy score. Discrepancies were apparent in both groups but not in the same direction; the highest rated images were under-anticipated and the lowest rated pictures were over-anticipated. The novel features of this task, including a direct comparison between anticipatory and consummatory pleasure ratings of the *same* image and the use of images tailored to the individual, have enabled this pattern to be identified in both groups. The discrepancy scores were significantly larger in the schizophrenia group compared to controls suggesting a weaker link between actual and anticipated experience.

10.3.3 Experience Sampling Study

Experience sampling is growing in popularity but at the time of the study design very few feasibility studies had been conducted. Since this time some have been published (Kimhy, Vakhrusheva, Liu, et al., 2014; Palmier-Claus et al., 2012). The finding of high completion rates (70-80%) in these studies was extended by examining adherence rates across different times and different days during the experience sampling week to identify possible fatigue effects. The results showed that adherence is lower in the schizophrenia group in the morning (before 11.30am) compared to the rest of the day. This was not associated with medication dosage or symptom levels.

10.3.3.1 Acceptability and Validity of Experience Sampling Study

The other novel approach taken in this work is the inclusion of a feedback questionnaire regarding the participants' experience of the week. The results from this questionnaire found that the training provided and the experience of taking part was acceptable. The participants' weeks were not substantially disrupted by taking part in either group. However, higher levels of disruption were associated with lower completion rates in the schizophrenia group. This was important to consider because of potential responsivity (i.e. where participants begin to adapt their daily life to accommodate questionnaire completion). The results suggest responsivity is not a significant issue when using this protocol as very few people reported disruption to the week but minimising disruption for people with schizophrenia may increase completion. The overall conclusion is that the results from the ESM week can be considered a reasonable reflection of usual experience and that participation in the study was acceptable for participants.

10.3.3.2 Between-Group Differences in TEP Model Constructs and Mood

The experience sampling study replicated the finding that people with schizophrenia had elevated negative mood and similar positive mood compared to controls; this has been termed "affective ambivalence" (Oorschot et al., 2013; Sanchez et al., 2014). Anticipatory and consummatory pleasure were both higher in people with schizophrenia compared to controls. This contradicts the anticipatory pleasure deficit hypothesis proposed in the TEP model. This was also different to the findings of the COP task which may reflect the limited ability of images to evoke strong emotional reactions compared to everyday life scenarios. Motivation was similar between the groups, but expectation was lower in the schizophrenia group. In line with the hypothesis, people with schizophrenia carried out fewer functional activities, spent more time resting and "doing nothing". There was no difference for time spent in leisure activities which replicates findings from previous studies (Oorschot et al., 2012).

10.3.3.3 The Role of Current Context

The role of context, specifically mood and current enjoyment, was examined and the results showed that the anticipatory pleasure and expectation in people with schizophrenia was more strongly influenced by positive affect, negative affect and consummatory pleasure. In the control group anticipatory pleasure predicted expectation which in turn predicted activity occurring at the next beep and this provides some support for the hypothesised pathway to activity in the TEP model (see Figure 27). These links were not present in people with schizophrenia, suggesting that these individuals may have difficulties connecting components of the pathway rather than experiencing a deficit in one specific component.

10.3.3.4 Social- Specific Findings

As in the COP task, distinct social items were included. Participants in the ESM study were asked to complete separate questions relating to socialising and their associated enjoyment. The support for this distinction is discussed in detail in Chapter 1 (Page 33) and social-specific questions have been included in the previous experience sampling literature (Granholm et al., 2013; Kimhy, Vakhrusheva, Khan, et al., 2014). The social findings revealed intact consummatory and anticipatory pleasure in the schizophrenia group, with the exception of trend lower consummatory pleasure when alone. Despite these low pleasure ratings, people with schizophrenia preferred to be alone and with others compared to controls. People with schizophrenia and controls spent similar amounts of time with familiar others, strangers and alone.

10.3.3.5 Relationships between ESM Ratings and Negative Symptom Measures

The ESM data provided an opportunity to test the proposal from the TEP model that an anticipatory, not consummatory, pleasure deficit underlies high experiential negative symptom scores and low functioning. Mixed support for this proposal was found from the CAINS experiential subscale correlating significantly with the majority of ESM anticipatory

ratings and activity levels. This measure did, however, also correlate with consummatory pleasure in contrast to the hypothesis from the TEP model. The PANSS depressed, disorganised and negative subscales showed only limited associations with anticipatory pleasure or activity levels and none with consummatory pleasure. These disparate findings from the two measures may be due to the increased specificity of the CAINS and recommends it as a measure of negative symptoms in future research. This is similar to the findings from the COP task which also reported associations between negative symptom measures and both consummatory and anticipatory pleasure. These combined findings suggest that negative symptom measures, particularly the interviews similar to the PANSS, cannot accurately differentiate between anticipatory and consummatory pleasure.

10.3.3.6 Predictors of Future Activity

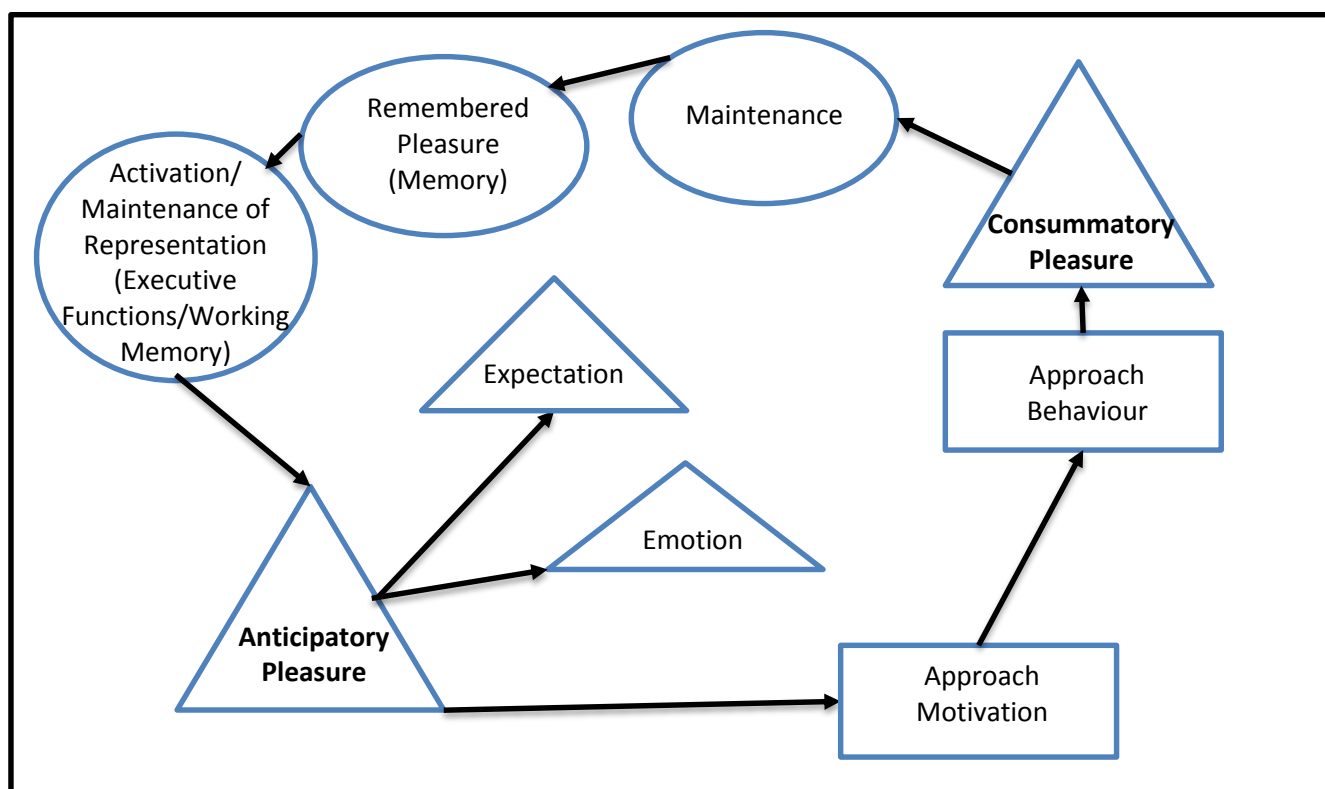
The temporal and rich nature of this data has enabled the processes that drive activities occurring to be identified. There appears to be a deficit in people with schizophrenia when completing the pathway proposed in the TEP model from anticipation to actual experience. There is a larger discrepancy between these two ratings on the COP task in people with schizophrenia and anticipation does not predict activity in the schizophrenia group in the experience sampling study.

10.3 Interpretation of the Findings

10.3.1 Temporal Experience of Pleasure Model (Kring & Caponigro, 2010)

The aim of this body of work was to develop new assessments of the constructs hypothesised to contribute to poor functioning in people with schizophrenia (i.e. anticipatory pleasure, motivation). This will provide clarity regarding where the deficits may lie in people with schizophrenia and enable the relationships with other constructs in the model (memory, executive functions) to be tested more accurately (see Figure 27).

Figure 27: The adapted temporal experience of pleasure model



The central hypothesis proposed to explain anhedonia in people with schizophrenia is a specific deficit in anticipatory pleasure which leads to low motivation and activity levels. The findings from the TEPS, COP task and ESM study contradict this hypothesis. People with schizophrenia showed similar anticipatory pleasure ratings to controls in the TEPS and COP task and heightened or similar anticipatory ratings in the ESM study. The COP task revealed that when compared to consummatory ratings of the same image people with schizophrenia both under- and over-estimate anticipatory pleasure and there is a larger discrepancy overall in this group compared to controls.

In the context of the TEP model this suggests that there may be some deficits in the processes in circles in Figure 28 (emotional memory, working memory, executive functions) which are hypothesised to play a role between consummatory pleasure and anticipatory pleasure (Kring & Barch, 2014) that result in larger discrepancies. Cognitive difficulties such as executive function and working memory deficits are a potential candidate as these may lead to difficulties activating or maintaining the representation of the future event when predicting (Burbridge & Barch, 2007). However, as discussed in Chapter 2 the findings from

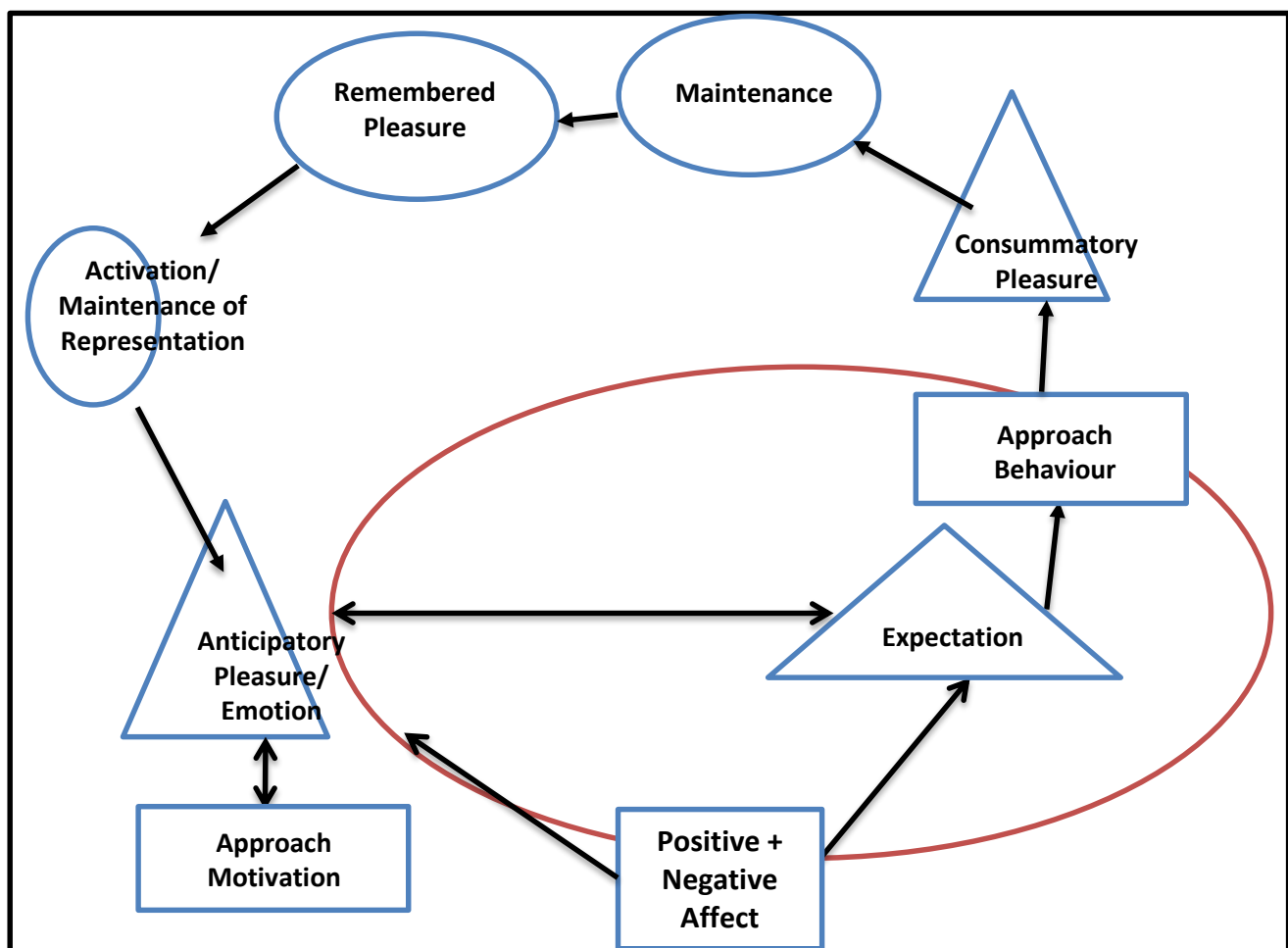
the systematic review regarding a link between executive functions and emotional deficits in people with schizophrenia are mixed. A more accurate and reliable paradigm such as the COP task could be used in future research instead of self-report measures, such as the TEPS, to assess the role of executive functions in anticipatory pleasure.

The experience sampling questionnaire contained items assessing the processes in the triangles and squares in Figure 28. The hypothesis presented in the TEP model is that anticipatory pleasure, which consists of *both* the cognitive *expectation* that the activity will occur and the *emotion* or pleasure that is associated with that expectation, drives motivation which drives behaviours. The findings from the experience sampling study provide mixed support for this hypothesis. In the control group the emotion component of anticipatory pleasure was linked to the expectation component. However, it was only the expectation which drove activities, not motivation or anticipatory pleasure ratings. In the schizophrenia group anticipatory pleasure was still linked to expectation and motivation but none of these factors predicted activity. There was also support for a link between consummatory and anticipatory pleasure in the experience sampling findings, supporting the cyclical form of the model.

Mood is different from the specific anticipatory emotion described in the TEP model as it refers to an overall emotional state that incorporates a range of emotions e.g. happy, satisfied or relaxed vs. guilty, anxious or hostile. The emotion in the TEP model on the other hand is specifically linked to the expectation that a future activity will occur. Indeed, the TEP model only includes the specific emotion and does not account for the role of mood in the process of anticipating pleasure. The findings from this study highlight the influence of mood on anticipatory pleasure and expectation which is important to consider as it seems that negative affect is elevated in everyday life, alongside intact positive affect, in people with schizophrenia. Thus the findings from this study suggest modification of the TEP model to remove the initially proposed pathway from anticipatory pleasure via motivation to activity and replace it with anticipatory pleasure leading to activity via expectation. Positive and negative affect which are not included in the original TEP model have also been shown to be important in the ESM study, although positive affect alone was associated with anticipation in the TEPS and COP task studies (see Figure 28). Rather than reduced anticipatory pleasure people with schizophrenia seem to have trouble utilising intact or

higher anticipatory pleasure to drive higher expectation and increased activity (the constructs contained within the red circle). The factors which contribute to this difficulty completing the pathway to activity need to be identified. The findings from this thesis suggest targeting these factors would increase the amount of functional and leisure activities in people with schizophrenia.

Figure 28: The updated temporal experience of pleasure model



10.3.2 Why do People with Schizophrenia have Difficulty Linking Anticipation and Activity?

The work conducted in this thesis points at a specific deficit in utilising anticipatory pleasure and expectation to drive future activities. It seems plausible to hypothesise that cognitive deficits; specifically in working memory and executive functions may be potential

candidates for a barrier between anticipating pleasure from an activity and engaging in it (Fioravanti et al., 2012; N. F. Forbes et al., 2009). Authors have proposed that problems with working memory and executive functions may lead to a deficit in maintaining a representation of the activity and pleasure associated with it which contributes to low anticipatory pleasure (Burbridge & Barch, 2007; Gold et al., 2008). The PANSS disorganised subscale, which could be considered a proxy measure for cognitive difficulties, provides some support for this hypothesis as it correlated with anticipatory ratings in the COP task. This support is limited by the finding that it was not associated with anticipation in everyday life in the ESM study. The findings from this thesis suggest that anticipatory pleasure may be intact, replicating findings from other studies (Gard, Sanchez, Cooper, et al., 2014; Trémeau et al., 2014).

Instead, a deficit in executive functions may contribute to problems further along the pathway, specifically when utilising anticipatory pleasure to drive activity. In relation to the methodologies used in this work it may be that individuals with schizophrenia cannot hold a vivid enough representation in mind to replicate the extremes of their emotions “in the moment” in the COP task or drive behaviour. This fits with findings in the literature indicating that a deficit in maintaining representations of emotions over time results in inconsistent preferences or choices in people with schizophrenia compared to controls (Gard et al., 2011; Heerey & Gold, 2007; Ursu et al., 2011). In these previous studies the delay between the two presentations of the image was short (3 seconds in the study by Gard and colleagues) compared to the COP task (20-30mins) and the ESM study was conducted in everyday life where the delay between anticipation and experience was much longer than a matter of minutes. Executive functions contribute to planning ability which has been linked to poor functional outcomes in people with schizophrenia (Holt, Wolf, Funke, Weisbrod, & Kaiser, 2013). An inability to plan future activities or visualise the necessary steps to achieve your goals may present a significant barrier to engaging in activities, even if they are highly anticipated, in people with schizophrenia.

Executive function deficits such as reduced inhibition (Vercammen et al., 2012) or control of attention (Hahn et al., 2010) may also lead to an increased influence of the current context on the prediction of future emotions in people with schizophrenia. It is important to note that in the COP task the pattern of results demonstrating both under- and

over-anticipation was the same in both groups but was exaggerated in people with schizophrenia. This suggests that accurate anticipation is not adaptive and should not be the target of any interventions focused on anticipatory pleasure. This is a replicated finding in the healthy control literature with examples of people both under-and over-anticipating the positive or negative affect they will experience during future activities (Gilbert & Wilson, 2007). These authors suggest that affective forecasting is unduly influenced by the current context in which the person is making their prediction e.g. mood, weather, health, leading to a “context bias” influencing these forecasts. For example, higher levels of negative mood, as have been reported in the schizophrenia group, at the time of the anticipation, would be hypothesised to influence the expected enjoyment from an activity in the future. This thesis provides some evidence for this bias having a larger influence in the schizophrenia group. Current mood and enjoyment are associated with anticipatory ratings of pleasure and motivation in both groups supporting the idea of a context bias; however, these associations were significantly stronger in the schizophrenia group and occurred more frequently with positive compared to negative affect. This suggests that the disparity seen between anticipatory ratings and activity or actual experience may be due to the exaggerated influence of context bias on anticipation in people with schizophrenia. It could be that this process is adaptive at the level at which it occurs in control participants and indeed previous studies have shown that high anticipatory pleasure increases wellbeing (Gilbert & Abdullah, 2002).

Affective ambivalence means that elevated negative affect is experienced alongside intact positive affect in people (Trémeau et al., 2009). These two mood constructs have opposing influences on anticipatory pleasure and expectation but it is not clear whether this means the total influence is minimal or fluctuating from one or the other being more dominant. The increased influence of context bias could perhaps be linked to executive function deficits such as input source selection (Luck & Gold, 2008) or attention control (Hahn et al., 2010). In order to minimise the effect of current context when anticipating, an individual needs to carefully select relevant information while blocking out irrelevant information such as the current weather or mood. This may place a high working load on executive functions and working memory, which have a reduced capacity in people with schizophrenia (Erickson et al., 2014). If this capacity is overwhelmed this would enable

current context to have a larger influence on the process of anticipation, particularly as it requires little cognitive effort to access current emotion and experience.

A recent review from Green et al. (2015) also highlighted effort-cost computation as a growing field which has highlighted some deficits that may contribute to low motivation in people with schizophrenia. Studies have shown that people with schizophrenia make sub-optimal choices when these are based on the amount of effort required to attain a reward (Treadway et al., 2015). This is not an overall lower amount of effort exerted across the whole task as people with schizophrenia exert themselves a similar amount as controls, but there is a sub-optimal allocation of this effort. These findings relate, in particular, to the experience sampling findings presented in this thesis. It could be that people with schizophrenia over-estimate the effort required to engage in the activities they anticipate as being enjoyable and thus reduce their expectation ratings and activity levels. Increased anticipatory pleasure may contribute to this in a maladaptive manner by inflating the effort computations as individuals may assume more enjoyable activities require more effort to engage with. This potential association between anticipatory pleasure and effort computation is an important one to consider in future research.

There has been some discussion in the literature around the role of negative (low-pleasure) or defeatist beliefs as a barrier to engaging with activities in people with schizophrenia (G. P. Strauss & Gold, 2012). There is some evidence that defeatist beliefs are linked to negative symptoms which then predict poor functioning (Couture, Blanchard, & Bennett, 2011; Quinlan, Roesch, & Granholm, 2014). These beliefs may interfere with the process of translating anticipated pleasure into activity as has been reported in the findings from the experience sampling study in this body of work. An individual may rate the anticipatory pleasure for an activity highly but then be deterred from engaging with that activity because they believe they will not be able to (defeatist belief) or that it will not be as good as they expect if they did (negative, low-pleasure belief). Low self-esteem may also contribute to these defeatist beliefs. This is a common problem in schizophrenia with links to poor outcomes such as suicidality and co-morbid anxiety and affective disorders (Fulginiti & Brekke, 2015; Karatzias, Gumley, Power, & O'Grady, 2007). Low self-esteem is considered an important factor for engagement in psychological therapy for psychosis (Sarin & Wallin, 2014). As yet it is unclear whether low self-esteem may influence the anticipation of

pleasure or motivation through increased negative affect, defeatist beliefs or both. This is an important avenue for future research.

A recent experience sampling study found that a sample of individuals with schizophrenia, with similar levels of negative symptoms to the sample in this work, set far fewer goals that were driven by a need for autonomy or competence compared to controls (Gard, Sanchez, Starr, et al., 2014). In line with self-determination theory (Ryan & Deci, 2000) their goals reflected a disconnected-disengaged state where the majority were set “to pass the time” or “because there is nothing else to do”. Individuals with many years of illness experience may have had their sense of autonomy or competence compromised by experiences that remove their freedom of choice e.g. being detained or symptoms that increase the difficulty of making decisions. This could contribute to a distorted sense of self that leads to difficulties in goal-setting and motivation (Moe & Docherty, 2014). Sense of agency, the extent to which we consider ourselves responsible for our actions, has also been shown to be lower in people with schizophrenia with predominantly negative symptoms when compared to a low negative symptom group (Maeda et al., 2013). Another study reports that low self-efficacy predicts higher levels of anhedonia in people with schizophrenia spectrum disorders (Cassar, Applegate, & Bentall, 2013). Considering the findings from the experience sampling study in the context of a low sense of agency suggests that although people with schizophrenia rate their anticipatory pleasure highly they do not expect this anticipation to drive future activities and instead are reliant on the context to engage them in activities. This low sense of agency may contribute to the low ratings of expectation and reduced activity levels in the context of increased anticipatory pleasure in the experience sampling study.

10.4 Limitations

The results of the studies presented must be interpreted in the context of some limitations. Firstly, as confirmed by the findings described in Chapter 9, the use of IAPS images as stimuli in the COP task is limited compared to everyday life experiences but the images have good efficacy as stimuli for inclusion in an experimental paradigm. This limitation was one reason for including experience sampling alongside the experimental task

and the anticipatory ratings from the COP task were externally validated using this approach. The other potential limitation in the COP task is the inclusion of a learning component as there are well-documented learning deficits in people with schizophrenia (Reichenberg et al., 2014). However, the cognitive load was minimised and learning was controlled for in the design of the task. Although people with schizophrenia completed fewer correct trials than controls this was not associated with the ratings. It was considered important to include a learning phase, despite this potential limitation, as anticipatory pleasure requires learning in most situations and this task is therefore more similar to everyday life.

The categories of activity in the ESM study were quite broad and a recent study asked for more detail regarding the nature of activities completed (Gard, Sanchez, Cooper, et al., 2014). They found that the activities completed by the people with schizophrenia classed as “leisure” or “functional” were actually less effortful than the activities in the same categories completed by control participants e.g. watching a film on TV at home compared to renting a DVD or going to the cinema (Gard, Sanchez, Cooper, et al., 2014). A service user advisory group reviewed the activity categories in this study and felt they were comprehensive, but the lack of detail within each category meant these were unable to be investigated in detail. There is also the concern that although an anticipated and actual activity may belong to the same category in the ESM questionnaire such as “eating” they may have been very different e.g. eating an apple vs. having a roast dinner. More detailed categories or open-ended questions would have allowed this to be controlled for and the effort required for the different activities to be estimated.

In addition, the findings from the ESM study suggest that expectation is an important driver of activity in the control group. Although motivation and anticipatory pleasure questions for social activities were included, expectation was not, which meant this study could not replicate this finding for socialising. Application of the findings to the wider population of individuals with this diagnosis is perhaps limited as the sample was selected to have at least mild negative symptoms. This criterion was included to ensure the people recruited would be experiencing symptoms relevant to the development of an intervention for negative symptoms. However, positive symptoms were low in the sample and the

average age was 40 which may limit the generalisability of the conclusions to both younger people with this diagnosis and those with a wider range of positive symptoms.

10.5 Future Directions for Research

10.5.1 Current Utility and Further Development of the COP Task

The COP task has demonstrated that it is a reliable and valid assessment of anticipatory pleasure and that it has high potential as an outcome measure for trials targeting this construct. The findings suggest the COP task could be used to assess the discrepancy between anticipatory and consummatory pleasure with a reduced (but not eliminated) discrepancy indicating improvement. This task could also be utilised in other areas of mental health research in which a deficit in the experience of pleasure is implicated such as depression (Sherdell, Waugh, & Gotlib, 2012) and Parkinson's disease (Loas, Duru, Godefroy, & Krystkowiak, 2014). An additional feature which could be added to the COP task is concurrent assessment of negative affect in response to the images, as well as the positive affect which is measured in the current version. This would enable a replication of the previous findings of affective ambivalence to be made and examine the impact of both these mood factors on anticipatory pleasure ratings.

10.5.2 Executive Function and Working Memory Deficits

Including a thorough cognitive assessment alongside the COP task is recommended for future research to directly test the hypothesis that executive function and working memory deficits in particular contribute to the larger discrepancy between anticipatory and consummatory pleasure in people with schizophrenia (Burbridge & Barch, 2007; Cohen et al., 2011). Other studies have examined the contribution of cognition to anhedonia in fMRI studies (P. O. Harvey, Armony, Malla, & Lepage, 2010; Larquet et al., 2010; Ursu et al., 2011) and the COP task could also be easily adapted for use in the scanner. This would allow the testing of the hypothesis that executive function deficits, which appear to be localised to the orbitofrontal cortex, contribute to the discrepancy seen in the task. It would also be interesting to examine the role of the dorsolateral prefrontal cortex and ventromedial

prefrontal cortex in the anticipatory phase of the task as these regions have been heavily implicated in reward prediction (G. P. Strauss et al., 2013) (see Chapter 1 for full discussion).

10.5.3 Further Development of the Experience Sampling Protocol

The current findings from this ESM study suggest additional items could be included in the questionnaire to test some of the hypotheses which have arisen. One of these is defeatist beliefs; cognitions such as these have been assessed in the moment in studies examining positive symptoms (Udachina et al., 2014). It would be possible to include similar items assessing the strength of defeatist or low-pleasure beliefs in the moment and their impact on activity levels. There are also computerised neuropsychological assessments being developed, particularly in the dementia and older-adults literature, that could be adapted for use in experience sampling studies (Gates & Kochan, 2015). “Smart home” technology is one example; this enables participants’ functioning to be assessed in their own home whilst they carry out everyday tasks (Dawadi, Cook, Schmitter-Edgecombe, & Parsey, 2013). Another study compared an ESM assessment of semantic memory, completed on a mobile phone, with traditional assessments of cognition and found that neuroimaging markers were only related to the “in the moment” memory assessment in a cohort of elderly rural residents (Allard et al., 2014). Both of these studies advocate mobile technologies as a feasible and important tool in the early detection and monitoring of cognitive decline in people at risk of dementia. A mobile assessment of cognition, or perhaps planning ability, would be a good addition to the ESM protocol used in this PhD as this would enable a test to be made of the hypothesis that cognitive deficits contribute to low activity levels in everyday life. A final hypothesis stated earlier in this chapter was that the difficulty utilising anticipation to drive activity in people with schizophrenia may be due to a learned lack of agency over many years of experiencing the symptoms of schizophrenia. The replication of this ESM study in a younger sample is important to determine when difficulties linking anticipation and activity emerge. Intervention at an early stage may be important to promote autonomy, competence and agency as an important therapeutic approach in the prevention of poor functional outcomes (Deci & Ryan, 2008).

The findings from both studies support the use of newer, more specific measures of negative symptoms, specifically the CAINS, in studies which are examining anticipatory

pleasure (Kring et al., 2013), in future research. The TEPS has received some support for its utility as a measure of anticipatory and consummatory pleasure as it was associated with COP task ratings. However, it was not related to everyday life ratings of anticipatory and consummatory pleasure or negative symptoms and functioning which suggests that it may have limited validity in everyday life.

The limits of the self-report measures emphasise the importance of experimental tasks in this field. The most informative studies included tasks which measured specific cognitive processes e.g. effort computation or maintenance of a representation, rather than a generalised executive function deficit. This specific theory-driven approach should be prioritised in future research (Green et al., 2015; Silverstein, 2008). The anticipatory pleasure ratings in the COP task correlate highly with the same construct in everyday life, validating its use as a measure of anticipatory pleasure. Where possible tasks which measure reward learning and effort/value computation should be validated using a similar approach to try to reduce the heterogeneity of tasks used in the field and guide the selection of those which are clinically relevant (Oorschot et al., 2009; Silverstein, 2008).

10.6 Clinical Implications

10.6.1 Therapeutic Targets

Experiential negative symptoms, particularly anhedonia and amotivation, are a largely unmet clinical need in people with a diagnosis of schizophrenia (Elis et al., 2013). These symptoms are present early (Fervaha, Foussias, et al., 2015; Schlosser et al., 2014; Velthorst et al., 2009), they are stable over time and linked to poor functional outcomes at 1yr, 8yr, 9yr, 13yr, 14yr and 16yr follow-ups (Loas, Azi, et al., 2009; Loas, Monestes, et al., 2009; Marchesi et al., 2015; Ventura et al., 2015). Poor functional outcomes largely translate into difficulties in highly valued activities such as getting a job, maintaining relationships and living independently (Rosenheck et al., 2006). These activities are all identified by service-users as key components of recovery (P. D. Harvey, 2009; Rose, 2014; The Schizophrenia Commission, 2012). Despite the clear long-term benefit an improvement in experiential negative symptoms would have, not only for the individual, but also for the cost to society (The Schizophrenia Commission, 2012), there are currently no targeted interventions

available (Fusar-Poli et al., 2014; National Institute for Health and Care Excellence (NICE), 2014).

As discussed in Chapters 1 and 2 this has largely been due to a lack of clarity surrounding which constructs should be targeted by treatments for anhedonia and/or amotivation. This body of work refutes the central hypothesis of the TEP model which states that there is a reduction in anticipatory pleasure in people with schizophrenia compared to controls (Kring & Caponigro, 2010). Instead, the current findings suggest that the difficulty lies in the presence of a barrier between anticipation and activity which limits the ability of people with schizophrenia to use anticipatory pleasure to drive their behaviour. This is a treatment target which should be considered in future research and intervention development. Potentially useful clinical approaches which could be adapted to target this difficulty are outlined below.

10.6.2 Clinical Approaches

Cognitive Behavioural Therapy for Psychosis (CBTp) (Turkington, Kingdon, & Weiden, 2006) has traditionally targeted the positive symptoms of schizophrenia. This therapy is grounded in the cognitive model of psychosis which proposes that reasoning and attributional biases are largely responsible to the development and maintenance of psychotic symptoms (Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001). CBTp has a good evidence base as an intervention for distress and positive symptom reduction (Wykes, 2014; Wykes, Steel, Everitt, & Tarrier, 2008), and although it is rare for a study to report anhedonia as an outcome measure, a few studies report a general improvement in negative symptoms and are summarised in a review (but sample sizes are small) (Rathod, Kingdon, Weiden, & Turkington, 2008). A recent meta-analysis on the topic suggests that CBTp does not improve negative symptoms. This is perhaps unsurprising as CBTp does not target these symptoms directly and the authors call for adaptations to better target the specific constructs that contribute to high negative symptom levels (Velthorst et al., 2014).

One trial of adapted CBTp for negative symptoms has been conducted by Grant, Huh, Perivoliotis, Stolar, and Beck (2012). The CBTp provided in this trial was adapted in several ways to target deficits in functioning as the outcome for people with a diagnosis of

schizophrenia experiencing predominantly negative symptoms. Firstly, the focus was on improving independence and quality of life and not symptom reduction. The therapists emphasised the client's assets, strengths and interests to motivate them towards concrete goals rather than discussing barriers or difficulties. The cognitive load of the therapy was reduced and the duration of therapy was extended from 12 months to 18 months. This adapted CBTp improved global functioning in the treatment group compared with those receiving standard care; avolition scores also improved but anhedonia did not. These adaptations are grounded in findings from previous CBTp trials, summarised in a review, that those CBT protocols with a larger behavioural element were more successful in people with schizophrenia (Wykes et al., 2008). To improve functional outcomes, the findings from this study and the wider literature suggest that a focus on "bridging the gap" from cognition to action rather than focusing heavily on the cognitions could be more efficacious in this population.

Therapists using manualised CBTp also identify personally relevant goals and use these to support the client's motivation in therapy. Imagery based techniques can enhance the vividness and specificity of the goal and link it to previous similar events. A pleasure diary in which individuals record their activities and enjoyment may support individuals to identify relevant goals in collaboration with the therapist. A similar mood diary has been used effectively in Cognitive Therapy of Depression (Beck, 1979) and deficits in anticipatory pleasure have also been described in this disorder (Sherdell et al., 2012). A pleasure diary, similar to that completed in the ESM study, could also be used as part of therapy to challenge the belief that the individual experiences low pleasure and highlight the activities they do find enjoyable. An imaginary diary of their desired activity schedule could also be compared to their real diary to highlight discrepancies and identify behavioural targets. Explicitly focussing on the cognitive dissonance between forecasted and experienced pleasure and enhancing the individual's awareness of the pleasure they experience could be beneficial. The awareness of one's own enjoyment of activities is not only linked to memory but also metacognition, defined as the ability to think of oneself and others. Metacognition has been shown to be reduced in people with high anhedonia/low depression and a diagnosis of schizophrenia (Buck et al., 2014). Metacognitive-Oriented Therapy (MOT) (Salvatore et al., 2012) helps the person build fuller narrative episodes and gain more

awareness of their emotions, particularly painful ones, as well as promoting feelings of strength and self-efficacy in the self-image. A further aim of this therapy is to help understand the social circumstances which elicit the feeling of vulnerability for that individual. These factors, particularly a loss of self-efficacy and awareness of emotions, could contribute to difficulties linking anticipation and activity and therefore MOT could be beneficial either as either an independent intervention or an adjunct to other therapies such as CBTp. A focus on metacognition may also develop more awareness of difficulties linking anticipating and activity in clients and foster compensatory mechanisms e.g. incorporating other information alongside anticipation in decision-making processes.

The findings from the experience sampling study suggest that people with schizophrenia currently have difficulty using their emotional resources alone to drive behaviour. The association between context, specifically mood, and anticipation seen across all three studies suggests changing the individual's environment to promote engagement in activities. These findings perhaps recommend an intervention such as behavioural activation (BA) (Lewinsohn, Friedman, & Katz, 1974). This has been developed to improve low motivation and anhedonia in depression and shows some initial encouraging findings (Churchill et al., 2013; Kahl, Winter, & Schweiger, 2012) although it does not appear to convey additional benefits when compared to CBT for people with depression (Hunot et al., 2013). The theoretical underpinnings of this therapy are in the behavioural approach, specifically the suggestion that the low motivation of people with depression may be due to a lack of reward and reinforcement in their environment (Lewinsohn et al., 1974). This theoretical approach was coupled with the observation that engaging in fewer pleasant activities results in lower motivation to engage in future pleasant activities and individuals can thus be caught in a downward spiral (Lewinsohn & Graf, 1973). This was also observed by Kraepelin (Kraepelin, 1981/1904) who described a link between engaging in enjoyable activities and the emergence of the individual's personality during recovery. Clients engaged in behavioural activation therapy are therefore supported to construct an activity schedule and are rewarded for engaging in more pleasant activities to try to increase the pleasure experienced in everyday life and ultimately improve wellbeing and reduce depression (Lewinsohn & Libet, 1972). Behavioural activation therapy could provide the additional support which people with schizophrenia appear to require to achieve their goals. People

with schizophrenia do consistently demonstrate reduced reward sensitivity so this may not always be an effective reinforcement tool (G. P. Strauss et al., 2013). A useful adaptation to BA suggested by self-determination theory may be a reduced focus on reward and a shift to promoting internal drives such as autonomy and competence which have been shown to be important in controls but reduced in people with schizophrenia (Gard, Sanchez, Starr, et al., 2014; Ryan & Deci, 2000).

A reduced ability to link anticipation and action also indicates a need for assertive outreach in this patient group (van Os, 2009). This approach to community care incorporates home visits, assertive care delivery, psychoeducation and small case-loads for each member of the care team. The findings of this thesis suggest that without this approach people with schizophrenia may find it difficult to motivate themselves to attend appointments, groups or therapy. Assertive outreach may be effective by maintaining support for the individual once goals have been identified, and serving as a more constant reminder of the targets the individual has set and the steps needed to achieve them. The findings from this study suggest high intensity support may be necessary as anticipating enjoyment or a sense of achievement may not be sufficient to guide the behaviour of someone with schizophrenia. Indeed, the improvements in symptoms seen using assertive outreach in community teams are promising (Kastner et al., 2015), although contrasting findings do also exist with no benefit to psychopathology reported (Aagaard & Müller-Nielsen, 2011).

If, as hypothesised earlier in this chapter, cognitive deficits contribute to the problem with utilising anticipatory pleasure to drive activity, then Cognitive Remediation Therapy (CRT) could have a beneficial effect. Some CRT trials have already reported an improvement in negative symptoms after therapy (Cella et al., 2014; Farreny, Aguado, Ochoa, Haro, & Usall, 2013) with one study reporting that reward learning on the WCST was enhanced after computerised CRT (Cella et al., 2013). Available cognitive training to enhance executive functions could be augmented to specifically target anticipating pleasure from future activities e.g. predicting the details of future events and incorporating emotions. Improvement in planning ability through CRT (Wykes et al., 2007) may also help individuals generate steps towards their goals and utilise their anticipatory pleasure and

expectation to guide them. Integrated psychological therapy (Roder, Mueller, Brenner, & Spaulding, 2010) incorporates cognitive remediation principles in a broad therapeutic approach alongside social cognition, social skills training and problem solving. This has shown improvements in negative symptoms across multiple studies (Mueller, Schmidt, & Roder, 2015; Roder, Mueller, & Schmidt, 2011), perhaps emphasising the importance of including higher-level training modules alongside those focused on neurocognition. This enables people to “bridge” the gap between the training and skills they need in their everyday lives more easily. Indeed, transfer of the cognitive skills learned in sessions to everyday life situations has been shown to be very important in the improvement of functional outcomes after CRT (Medalia & Saperstein, 2013). The findings from this body of work suggest that relying on previous experience alone is difficult for people with schizophrenia to link to future scenarios; making the links explicit between skills learned in therapy and difficulties faced in everyday life may convey large benefits to these individuals.

The findings from this thesis demonstrate the high acceptability of mobile technology for people with schizophrenia and encourage its use in therapy (G. P. Strauss, 2013b). Mobile devices could be adapted to enhance therapy by providing an online pleasure diary that could be shared with the therapist (Alvarez-Jimenez et al., 2014; Ben-Zeev et al., 2014). Such a tool could also generate prompts when activity levels are low which consist of tailored support and encouragement. For example, to support awareness of pleasant experiences and reduce reliance on emotional memory, the device could regularly remind individuals which activities they reported as enjoyable and perhaps also provide encouragement for them to engage in those activities again. Reminders or instructions for any useful techniques learned in therapy such as imagery could be provided via the device. The client could also be prompted regarding their goals and the steps they have planned to take towards them in a particular time-frame e.g. a day or week. This could also serve as an immediate reward for the clients as any achievements or progress towards their goals could be recorded as a visual aid which may encourage them to persevere. Smartphone applications are currently being designed to promote mental wellbeing and could be easily adapted to provide these functions (Ben-Zeev et al., 2014).

10.7 In Conclusion

The findings from this body of work suggest that in contrast to expectations anticipatory pleasure is not reduced in people with schizophrenia. Instead, the factors which contribute to negative symptoms and reduced activity are a large discrepancy between predicted and actual experience and difficulties in using anticipation to drive activity. This suggests that anticipatory pleasure may in fact be a blanket term for a dynamic process that drives activity differently depending on the event, activity or experience being anticipated. Future research should focus on identifying the barriers which prevent people with schizophrenia from achieving their goals or engaging in activities and test hypotheses evaluating the role of mood, defeatist beliefs and executive function. The findings from this PhD suggest that existing therapeutic techniques need to be adapted to target these difficulties and may then offer effective interventions. There are currently no targeted interventions available to tackle this symptom cluster, despite its significant impact on long-term functional outcomes. The healthy control literature shows that experiencing anticipatory pleasure and using this to drive activities such as holidays and socialising increases wellbeing. Strengthening the link between anticipatory pleasure and activity in people with schizophrenia through therapeutic development would have long-term benefits for quality of life.

References

- 4D. (2010). 4D Software v12 (Version 12).
- Aagaard, J., & Müller-Nielsen, K. (2011). Clinical outcome of assertive community treatment (ACT) in a rural area in Denmark: A casecontrol study with a 2-year follow-up. *Nord J Psychiatry*, 65(5), 299-305. doi: 10.3109/08039488.2010.544405
- Afonso, P., Brissos, S., Canas, F., Bobes, J., & Bernardo-Fernandez, I. (2014). Treatment adherence and quality of sleep in schizophrenia outpatients. *Int J Psychiatry Clin Pract*, 18(1), 70-76. doi: 10.3109/13651501.2013.845219
- Afonso, P., Figueira, M., & Paiva, T. (2014). Sleep–wake patterns in schizophrenia patients compared to healthy controls. *The World Journal of Biological Psychiatry*, 15(7), 517-524. doi: 10.3109/15622975.2012.756987
- Agid, O., McDonald, K., Siu, C., Tsoutsoulas, C., Wass, C., Zipursky, R. B., . . . Remington, G. (2012). Happiness in first-episode schizophrenia. *Schizophr Res*, 141(1), 98-103. doi: 10.1016/j.schres.2012.07.012
- Aleman, A., Hijman, R., de Haan, E. H., & Kahn, R. S. (1999). Memory impairment in schizophrenia: a meta-analysis. *Am J Psychiatry*, 156(9), 1358-1366.
- Aleman, A., Kahn, R. S., & Selten, J. (2003). Sex differences in the risk of schizophrenia: Evidence from meta-analysis. *Archives of General Psychiatry*, 60(6), 565-571. doi: 10.1001/archpsyc.60.6.565
- Allard, M., Husky, M., Catheline, G., Pelletier, A., Dilharreguy, B., Amieva, H., . . . Swendsen, J. (2014). Mobile Technologies in the Early Detection of Cognitive Decline. *PLoS One*, 9(12), e112197. doi: 10.1371/journal.pone.0112197
- Allott, K., Liu, P., Proffitt, T. M., & Killackey, E. (2011). Cognition at illness onset as a predictor of later functional outcome in early psychosis: systematic review and methodological critique. *Schizophr Res*, 125(2-3), 221-235. doi: 10.1016/j.schres.2010.11.001
- Alonso, V. (2014). Dealing with the negative symptoms of Schizophrenia Retrieved from <https://mypersonalrecoveryfromschizophrenia.wordpress.com/page/3/>
- Alvarez-Jimenez, M., Alcazar-Corcoles, M. A., Gonzalez-Blanch, C., Bendall, S., McGorry, P. D., & Gleeson, J. F. (2014). Online, social media and mobile technologies for psychosis treatment: a systematic review on novel user-led interventions. *Schizophr Res*, 156(1), 96-106. doi: 10.1016/j.schres.2014.03.021
- American Psychiatric Association. (1980). *Diagnostic and Statistican Manual of Mental Disorders* (Vol. 3). Washington, DC: American Psychiatric Association
- American Psychiatric Association. (1987). *Diagnostic and Statistical Manual of Mental Disorders (III-R)* (Vol. 3-Revised). Washington, DC: American Psychiatric Association.
- American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders* (Vol. 5). Washington, DC.
- Amr, M., & Volpe, F. M. (2013). Relationship between anhedonia and impulsivity in schizophrenia, major depression and schizoaffective disorder. *Asian J Psychiatr*, 6(6), 577-580. doi: 10.1016/j.ajp.2013.09.002
- Andreasen. (1982). Negative symptoms in schizophrenia. Definition and reliability. *Arch Gen Psychiatry*, 39(7), 784-788.
- Arias, F., Szerman, N., Vega, P., Mesias, B., Basurte, I., Morant, C., . . . Babin, F. (2013). Abuse or dependence on cannabis and other psychiatric disorders. Madrid study on dual pathology prevalence. *Actas Esp Psiquiatr*, 41(2), 122-129.
- Baier, M. (2010). Insight in schizophrenia: a review. *Curr Psychiatry Rep*, 12(4), 356-361. doi: 10.1007/s11920-010-0125-7
- Barch, D. M., Treadway, M. T., & Schoen, N. (2014). Effort, anhedonia, and function in schizophrenia: reduced effort allocation predicts amotivation and functional impairment. *Journal of Abnormal Psychology*, 123(2), 387-397. doi: 10.1037/a0036299

- Barch, D. M., Yodkovik, N., Sypher-Locke, H., & Hanewinkel, M. (2008). Intrinsic motivation in schizophrenia: relationships to cognitive function, depression, anxiety, and personality. *J Abnorm Psychol.*, 117(4), 776-787.
- Barrett, L. F., & Bliss-Moreau, E. (2009). Affect as a psychological primitive. *Advances in experimental social psychology*, 41, 167-218.
- Bartholomeusz, C. F., & Allott, K. (2012). Neurocognitive and Social Cognitive Approaches for Improving Functional Outcome in Early Psychosis: Theoretical Considerations and Current State of Evidence. *Schizophrenia Research and Treatment*, 2012, 815315. doi: 10.1155/2012/815315
- Becerril, K., & Barch, D. (2011). Influence of emotional processing on working memory in schizophrenia. *Schizophr Bull.*, 37(5), 1027-1038. Epub 2010 Feb 1022.
- Beck, A. T. (1979). *Cognitive Therapy of Depression*: Guilford Press.
- Ben-Zeev, D., Brenner, C. J., Begale, M., Duffecy, J., Mohr, D. C., & Mueser, K. T. (2014). Feasibility, acceptability, and preliminary efficacy of a smartphone intervention for schizophrenia. *Schizophr Bull*, 40(6), 1244-1253. doi: 10.1093/schbul/sbu033
- Ben-Zeev, D., Ellington, K., Swendsen, J., & Granholm, E. (2011). Examining a cognitive model of persecutory ideation in the daily life of people with schizophrenia: a computerized experience sampling study. *Schizophr Bull*, 37(6), 1248-1256. doi: 10.1093/schbul/sbq041
- Ben-Zeev, D., McHugo, G. J., Xie, H., Dobbins, K., & Young, M. A. (2012). Comparing retrospective reports to real-time/real-place mobile assessments in individuals with schizophrenia and a nonclinical comparison group. *Schizophr Bull*, 38(3), 396-404. doi: 10.1093/schbul/sbr171
- Ben-Zeev, D., Morris, S., Swendsen, J., & Granholm, E. (2012). Predicting the occurrence, conviction, distress, and disruption of different delusional experiences in the daily life of people with schizophrenia. *Schizophr Bull*, 38(4), 826-837. doi: 10.1093/schbul/sbq167
- Benjamini, Y., & Hochberg, Y. (1995). Controlling the False Discovery Rate: a Practical and Powerful Approach to Multiple Testing. *Journal of the Royal Statistical Society. Series B (Methodological)*, 57(1), 289-300. doi: 10.2307/2346101
- Bennett, C. M., & Miller, M. B. (2010). How reliable are the results from functional magnetic resonance imaging? *Ann N Y Acad Sci*, 1191, 133-155. doi: 10.1111/j.1749-6632.2010.05446.x
- Berenbaum, H., Kerns, J. G., Vernon, L. L., & Gomez, J. J. (2008). Cognitive correlates of schizophrenia signs and symptoms: II. Emotional disturbances. *Psychiatry Res.*, 159(1-2), 157-162. Epub 2008 Apr 2018.
- Berlin, I., Givry-Steiner, L., Lecrubier, Y., & Puech, A. J. (1998). Measures of anhedonia and hedonic responses to sucrose in depressive and schizophrenic patients in comparison with healthy subjects. *Eur Psychiatry.*, 13(6), 303-309.
- Berridge, K. C., & Robinson, T. E. (1998). What is the role of dopamine in reward: hedonic impact, reward learning, or incentive salience? *Brain Res Brain Res Rev*, 28(3), 309-369.
- Blanchard, J. J., Bellack, A. S., & Mueser, K. T. (1994). Affective and social-behavioral correlates of physical and social anhedonia in schizophrenia. *J Abnorm Psychol.*, 103(4), 719-728.
- Blanchard, J. J., & Cohen, A. S. (2006). The structure of negative symptoms within schizophrenia: implications for assessment. *Schizophr Bull.*, 32(2), 238-245. Epub 2005 Oct 2027.
- Blanchard, J. J., Horan, W. P., & Brown, S. A. (2001). Diagnostic differences in social anhedonia: a longitudinal study of schizophrenia and major depressive disorder. *J Abnorm Psychol.*, 110(3), 363-371.
- Bleuler, E. (1950/1908). Dementia praecox or the group of schizophrenias.
- Bodapati, A. S., & Herbener, E. S. (2014). The impact of social content and negative symptoms on affective ratings in schizophrenia. *Psychiatry Research*, 218(1-2), 25-30. doi: <http://dx.doi.org/10.1016/j.psychres.2014.03.039>
- Bowie, C. R., Depp, C., McGrath, J. A., Wolyniec, P., Mausbach, B. T., Thornquist, M. H., . . . Pulver, A. E. (2010). Prediction of Real-World Functional Disability in Chronic Mental Disorders: A

- Comparison of Schizophrenia and Bipolar Disorder. *American Journal of Psychiatry*, 167(9), 1116-1124. doi: 10.1176/appi.ajp.2010.09101406
- Bowie, C. R., Reichenberg, A., Patterson, T. L., Heaton, R. K., & Harvey, P. D. (2010). Determinants of Real-World Functional Performance in Schizophrenia Subjects: Correlations With Cognition, Functional Capacity, and Symptoms. *FOCUS*, 8(4), 638-646. doi: 10.1176/foc.8.4.foc638
- Boyce, N. (2011). The Lancet Technology: August, 2011. *The Lancet*, 378(9790), 475.
- Brebion, G., Amador, X., Smith, M. J., Malaspina, D., Sharif, Z., & Gorman, J. M. (1999). Opposite links of positive and negative symptomatology with memory errors in schizophrenia. *Psychiatry Res.*, 88(1), 15-24.
- Brebion, G., Bressan, R. A., Ohlsen, R. I., Pilowsky, L. S., & David, A. S. (2010). Production of atypical category exemplars in patients with schizophrenia. *J Int Neuropsychol Soc.*, 16(5), 822-828. Epub 2010 Jul 2018.
- Brebion, G., David, A. S., Jones, H., & Pilowsky, L. S. (2005). Hallucinations, negative symptoms, and response bias in a verbal recognition task in schizophrenia. *Neuropsychology.*, 19(5), 612-617.
- Brebion, G., David, A. S., Jones, H. M., Ohlsen, R., & Pilowsky, L. S. (2007). Temporal context discrimination in patients with schizophrenia: associations with auditory hallucinations and negative symptoms. *Neuropsychologia.*, 45(4), 817-823. Epub 2006 Sep 2022.
- Brebion, G., David, A. S., Ohlsen, R., Jones, H. M., & Pilowsky, L. S. (2007). Visual memory errors in schizophrenic patients with auditory and visual hallucinations. *J Int Neuropsychol Soc.*, 13(5), 832-838.
- Brebion, G., Ohlsen, R. I., Bressan, R. A., & David, A. S. (2012). Source memory errors in schizophrenia, hallucinations and negative symptoms: a synthesis of research findings. *Psychol Med.*, 42(12), 2543-2554. doi: 10.1017/S003329171200075X. Epub 003329171202012 Apr 003329171200027.
- Brenner, C. J., & Ben-Zeev, D. (2014). Affective forecasting in schizophrenia: comparing predictions to real-time Ecological Momentary Assessment (EMA) ratings. *Psychiatr Rehabil J*, 37(4), 316-320. doi: 10.1037/prj0000105
- Brose, E., & Woodward, N. D. (2015). Schizotypy and clinical symptoms, cognitive function, and quality of life in individuals with a psychotic disorder. *Schizophr Res*. doi: 10.1016/j.schres.2015.04.038
- Brown, E. C., Tas, C., Kuzu, D., Esen-Danaci, A., Roelofs, K., & Brune, M. (2014). Social approach and avoidance behaviour for negative emotions is modulated by endogenous oxytocin and paranoia in schizophrenia. *Psychiatry Res*, 219(3), 436-442. doi: 10.1016/j.psychres.2014.06.038
- Brown, J. K., Waltz, J. A., Strauss, G. P., McMahon, R. P., Frank, M. J., & Gold, J. M. (2013). Hypothetical decision making in schizophrenia: the role of expected value computation and "irrational" biases. *Psychiatry Res*, 209(2), 142-149. doi: 10.1016/j.psychres.2013.02.034
- Buck, K. D., McLeod, H. J., Gumley, A., Dimaggio, G., Buck, B. E., Minor, K. S., . . . Lysaker, P. H. (2014). Anhedonia in prolonged schizophrenia spectrum patients with relatively lower vs. higher levels of depression disorders: associations with deficits in social cognition and metacognition. *Conscious Cogn*, 29, 68-75. doi: 10.1016/j.concog.2014.07.005
- Burbridge, J. A., & Barch, D. M. (2007). Anhedonia and the experience of emotion in individuals with schizophrenia. *Journal of Abnormal Psychology*, 116(1), 30-42.
- Carpenter, W. T., Jr., Heinrichs, D. W., & Wagman, A. M. (1988). Deficit and nondeficit forms of schizophrenia: the concept. *Am J Psychiatry*, 145(5), 578-583.
- Cassar, R., Applegate, E., & Bentall, R. P. (2013). Poor savouring and low self-efficacy are predictors of anhedonia in patients with schizophrenia spectrum disorders. *Psychiatry Res*, 210(3), 830-834. doi: 10.1016/j.psychres.2013.09.017

- Cella, M., Bishara, A. J., Medin, E., Swan, S., Reeder, C., & Wykes, T. (2013). Identifying Cognitive Remediation Change Through Computational Modelling--Effects on Reinforcement Learning in Schizophrenia. *Schizophr Bull.* doi: 10.1093/schbul/sbt152
- Cella, M., Reeder, C., & Wykes, T. (2014). It is all in the factors: Effects of cognitive remediation on symptom dimensions. *Schizophrenia Research*, 156(1), 60-62. doi: 10.1016/j.schres.2014.03.032
- Chan, R. C., Shi, Y. F., Lai, M. K., Wang, Y. N., Wang, Y., & Kring, A. M. (2012). The Temporal Experience of Pleasure Scale (TEPS): exploration and confirmation of factor structure in a healthy Chinese sample. *PLoS One*, 7(4), e35352. doi: 10.1371/journal.pone.0035352
- Chan, R. C., Wang, Y., Huang, J., Shi, Y., Hong, X., Ma, Z., . . . Kring, A. M. (2010). Anticipatory and consummatory components of the experience of pleasure in schizophrenia: cross-cultural validation and extension. *Psychiatry Res.*, 175(1-2), 181-183. Epub 2009 Dec 2005.
- Chapman, L. J., Chapman, J. P., & Raulin, M. L. (1976). Scales for physical and social anhedonia. *J Abnorm Psychol.*, 85(4), 374-382.
- Chaturvedi, S. K., Rao, G. P., Mathai, P. J., Sarmukaddam, S., & Gopinath, P. S. (1985). Negative symptoms in schizophrenia and depression. *Indian J Psychiatry.*, 27(3), 237-241.
- Choi, S.-H., Lee, H., Ku, J., Yoon, K. J., & Kim, J.-J. (2013). Neural basis of anhedonia as a failure to predict pleasantness in schizophrenia. *The World Journal of Biological Psychiatry*, 1-9. doi: 10.3109/15622975.2013.819121
- Churchill, R., Moore, T. H., Furukawa, T. A., Caldwell, D. M., Davies, P., Jones, H., . . . Hunot, V. (2013). 'Third wave' cognitive and behavioural therapies versus treatment as usual for depression. *Cochrane Database Syst Rev*, 10, CD008705. doi: 10.1002/14651858.CD008705.pub2
- Cicero, D. C., Martin, E. A., Becker, T. M., & Kerns, J. G. (2014). Reinforcement learning deficits in people with schizophrenia persist after extended trials. *Psychiatry Research*, 220(3), 760-764. doi: <http://dx.doi.org/10.1016/j.psychres.2014.08.013>
- Cichocki, L., Cechnicki, A., Franczyk-Glita, J., Bladzinski, P., Kalisz, A., & Wronski, K. (2015). Quality of life in a 20-year follow-up study of people suffering from schizophrenia. *Compr Psychiatry*, 56, 133-140. doi: 10.1016/j.comppsy.2014.09.017
- Cohen, A. S., Alpert, M., Nienow, T. M., Dinzeo, T. J., & Docherty, N. M. (2008). Computerized measurement of negative symptoms in schizophrenia. *J Psychiatr Res.*, 42(10), 827-836. Epub 2007 Oct 2024.
- Cohen, A. S., & Minor, K. S. (2010). Emotional experience in patients with schizophrenia revisited: meta-analysis of laboratory studies. *Schizophrenia Bulletin*, 36(1), 143-150. Epub 2008 Jun 2017.
- Cohen, A. S., Najolia, G. M., Brown, L. A., & Minor, K. S. (2011). The state-trait disjunction of anhedonia in schizophrenia: potential affective, cognitive and social-based mechanisms. *Clinical Psychology Review*, 31(3), 440-448. Epub 2010 Nov 2012.
- Cotter, J., Drake, R. J., Bucci, S., Firth, J., Edge, D., & Yung, A. R. (2014). What drives poor functioning in the at-risk mental state? A systematic review. *Schizophr Res*, 159(2-3), 267-277. doi: 10.1016/j.schres.2014.09.012
- Couture, S. M., Blanchard, J. J., & Bennett, M. E. (2011). Negative expectancy appraisals and defeatist performance beliefs and negative symptoms of schizophrenia. *Psychiatry Res.*, 189(1), 43-48. Epub 2011 Jun 2024.
- Crespo-Facorro, B., Paradiso, S., Andreasen, N. C., O'Leary, D. S., Watkins, G. L., Ponto, L. L., & Hichwa, R. D. (2001). Neural mechanisms of anhedonia in schizophrenia: a PET study of response to unpleasant and pleasant odors. *JAMA.*, 286(4), 427-435.
- Csipke, E., Flach, C., McCrone, P., Rose, D., Tilley, J., Wykes, T., & Craig, T. (2014). Inpatient care 50 years after the process of deinstitutionalisation. *Social Psychiatry and Psychiatric Epidemiology*, 49(4), 665-671. doi: 10.1007/s00127-013-0788-6

- Danivas, V., & Venkatasubramanian, G. (2013). Current perspectives on chlorpromazine equivalents: comparing apples and oranges! *Indian Journal of Psychiatry*, 55(2), 207-208. doi: 10.4103/0019-5545.111475
- Dawadi, P. N., Cook, D. J., Schmitter-Edgecombe, M., & Parsey, C. (2013). Automated assessment of cognitive health using smart home technologies. *Technol Health Care*, 21(4), 323-343. doi: 10.3233/thc-130734
- Deci, E. L., & Ryan, R. M. (2008). Facilitating optimal motivation and psychological well-being across life's domains. *Canadian Psychology*, 49(1), 14-23. doi: 10.1037/0708-5591.49.1.14
- Delespaul, P., & deVries, M. W. (1987). The daily life of ambulatory chronic mental patients. *J Nerv Ment Dis*, 175(9), 537-544.
- Delespaul, P., deVries, M. W., & van Os, J. (2002). Determinants of occurrence and recovery from hallucinations in daily life. *Social Psychiatry and Psychiatric Epidemiology*, 37(3), 97-104.
- Demily, C., Attala, N., Fouldrin, G., Czernecki, V., Menard, J. F., Lamy, S., . . . Thibaut, F. (2010). The Emotional Stroop task: a comparison between schizophrenic subjects and controls. *Eur Psychiatry*, 25(2), 75-79. Epub 2009 Jun 2021.
- Dichter, G. S., Bellion, C., Casp, M., & Belger, A. (2010). Impaired modulation of attention and emotion in schizophrenia. *Schizophr Bull*, 36(3), 595-606. Epub 2008 Oct 2008.
- Docx, L., de la Asuncion, J., Sabbe, B., Hoste, L., Baeten, R., Waraerts, N., & Morrens, M. (2015). Effort discounting and its association with negative symptoms in schizophrenia. *Cogn Neuropsychiatry*, 20(2), 172-185. doi: 10.1080/13546805.2014.993463
- Doll, B., Waltz, J., Cockburn, J., Brown, J., Frank, M., & Gold, J. (2014). Reduced susceptibility to confirmation bias in schizophrenia. *Cognitive, Affective, & Behavioral Neuroscience*, 14(2), 715-728. doi: 10.3758/s13415-014-0250-6
- Doop, M. L., & Park, S. (2006). On knowing and judging smells: identification and hedonic judgment of odors in schizophrenia. *Schizophr Res*, 81(2-3), 317-319. Epub 2005 Sep 2021.
- Dowd, E. C., & Barch, D. M. (2010). Anhedonia and emotional experience in schizophrenia: neural and behavioral indicators. *Biological Psychiatry*, 67(10), 902-911. Epub 2009 Dec 2009.
- Dowd, E. C., & Barch, D. M. (2012). Pavlovian reward prediction and receipt in schizophrenia: relationship to anhedonia. *PLoS One*, 7(5), e35622. Epub 2012 May 2012.
- Earnst, K. S., & Kring, A. M. (1999). Emotional responding in deficit and non-deficit schizophrenia. *Psychiatry Res*, 88(3), 191-207.
- Edwards, C. J., Cella, M., Tarrier, N., & Wykes, T. (2015). Predicting the future in schizophrenia: The discrepancy between anticipatory and consummatory pleasure. *Psychiatry Res*. doi: 10.1016/j.psychres.2015.05.091
- Elis, O., Caponigro, J. M., & Kring, A. M. (2013). Psychosocial treatments for negative symptoms in schizophrenia: current practices and future directions. *Clinical Psychology Review*, 33(8), 914-928. doi: 10.1016/j.cpr.2013.07.001
- Ergul, C., & Uçok, A. (2015). Negative symptom subgroups have different effects on the clinical course of schizophrenia after the first episode: a 24-month follow up study. *Eur Psychiatry*, 30(1), 14-19. doi: 10.1016/j.eurpsy.2014.07.005
- Erickson, M., Hahn, B., Leonard, C., Robinson, B., Luck, S., & Gold, J. (2014). Enhanced vulnerability to distraction does not account for working memory capacity reduction in people with schizophrenia. *Schizophr Res Cogn*, 1(3), 149-154. doi: 10.1016/j.scog.2014.09.001
- Esslinger, C., Englisch, S., Inta, D., Rausch, F., Schirmbeck, F., Mier, D., . . . Zink, M. (2012). Ventral striatal activation during attribution of stimulus saliency and reward anticipation is correlated in unmedicated first episode schizophrenia patients. *Schizophr Res*, 140(1-3), 114-121. doi: 10.1016/j.schres.2012.06.025
- Farreny, A., Aguado, J., Ochoa, S., Haro, J. M., & Usall, J. (2013). The role of negative symptoms in the context of cognitive remediation for schizophrenia. *Schizophr Res*, 150(1), 58-63. doi: 10.1016/j.schres.2013.08.008

- Fatouros-Bergman, H., Cervenka, S., Flyckt, L., Edman, G., & Farde, L. (2014). Meta-analysis of cognitive performance in drug-naïve patients with schizophrenia. *Schizophr Res*, 158(1-3), 156-162. doi: 10.1016/j.schres.2014.06.034
- Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39(2), 175-191. doi: 10.3758/BF03193146
- Favrod, J., Ernst, F., Giuliani, F., & Bonsack, C. (2009). [Validation of the Temporal Experience of Pleasure Scale (TEPS) in a French-speaking environment]. *Encephale*, 35(3), 241-248. doi: 10.1016/j.encep.2008.02.013
- Favrod, J., Giuliani, F., Ernst, F., & Bonsack, C. (2010). Anticipatory pleasure skills training: a new intervention to reduce anhedonia in schizophrenia. *Perspectives in Psychiatric Care*, 46(3), 171-181.
- Fervaha, G., Agid, O., Takeuchi, H., Foussias, G., & Remington, G. (2014). Effect of antipsychotic medication on overall life satisfaction among individuals with chronic schizophrenia: findings from the NIMH CATIE study. *Eur Neuropsychopharmacol*, 24(7), 1078-1085. doi: 10.1016/j.euroneuro.2014.03.001
- Fervaha, G., Foussias, G., Agid, O., & Remington, G. (2013). Amotivation and functional outcomes in early schizophrenia. *Psychiatry Res*, 210(2), 665-668. doi: 10.1016/j.psychres.2013.07.024
- Fervaha, G., Foussias, G., Agid, O., & Remington, G. (2015). Motivational deficits in early schizophrenia: Prevalent, persistent, and key determinants of functional outcome. *Schizophr Res*. doi: 10.1016/j.schres.2015.04.040
- Fervaha, G., Graff-Guerrero, A., Zakzanis, K. K., Foussias, G., Agid, O., & Remington, G. (2013). Incentive motivation deficits in schizophrenia reflect effort computation impairments during cost-benefit decision-making. *J Psychiatr Res*, 47(11), 1590-1596. doi: 10.1016/j.jpsychires.2013.08.003
- Fervaha, G., Takeuchi, H., Lee, J., Foussias, G., Fletcher, P. J., Agid, O., & Remington, G. (2015). Antipsychotics and Amotivation. *Neuropsychopharmacology*. doi: 10.1038/npp.2015.3
- Field, A. (2009). *Discovering Statistics Using SPSS* (3 ed.). London: SAGE Publications Ltd.
- Fioravanti, M., Bianchi, V., & Cinti, M. E. (2012). Cognitive deficits in schizophrenia: an updated metanalysis of the scientific evidence. *BMC Psychiatry*, 12, 64. doi: 10.1186/1471-244x-12-64
- First, M. B., Spitzer, Robert L., Gibbon Miriam and Williams, Janet B.W., . (2002). *Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Patient Edition. (SCID-I/P)*. New York State Psychiatric Institute New York: Biometrics Research.
- Folley, B. S., & Park, S. (2010). Relative food preference and hedonic judgments in schizophrenia. *Psychiatry Res.*, 175(1-2), 33-37. Epub 2009 Nov 2020.
- Forbes, C., Blanchard, J. J., Bennett, M., Horan, W. P., Kring, A. M., & Gur, R. (2010). Initial development and preliminary validation of a new negative symptom measure: the Clinical Assessment Interview for Negative Symptoms (CAINS). *Schizophrenia Research*, 124(1-3), 36-42. Epub 2010 Sep 2024.
- Forbes, N. F., Carrick, L. A., McIntosh, A. M., & Lawrie, S. M. (2009). Working memory in schizophrenia: a meta-analysis. *Psychol Med*, 39(6), 889-905. doi: 10.1017/s0033291708004558
- Foussias, G., Mann, S., Zakzanis, K. K., van Reekum, R., Agid, O., & Remington, G. (2011). Prediction of longitudinal functional outcomes in schizophrenia: the impact of baseline motivational deficits. *Schizophrenia Research*, 132(1), 24-27. Epub 2011 Jul 2019.
- Fowler, D., Hodgekins, J., Painter, M., Reilly, T., Crane, C., Macmillan, I., . . . Jones, P. B. (2009). Cognitive behaviour therapy for improving social recovery in psychosis: a report from the ISREP MRC Trial Platform study (Improving Social Recovery in Early Psychosis). *Psychological Medicine*, 39(10), 1627-1636.

- Franke, P., Maier, W., Hardt, J., Hain, C., & Cornblatt, B. A. (1994). Attentional abilities and measures of schizotypy: their variation and covariation in schizophrenic patients, their siblings, and normal control subjects. *Psychiatry Res.*, 54(3), 259-272.
- Frederickson, B. L. (2001). The Role of Positive Emotions in Positive Psychology: The Broaden-and-Build Theory of Positive Emotions. *American Psychologist*, 56(3), 218-226.
- Frydecka, D., Eissa, A. M., Hewedi, D. H., Ali, M., Drapala, J., Misiak, B., . . . Moustafa, A. A. (2014). Impairments of working memory in schizophrenia and bipolar disorder: the effect of history of psychotic symptoms and different aspects of cognitive task demands. *Front Behav Neurosci*, 8, 416. doi: 10.3389/fnbeh.2014.00416
- Fulginiti, A., & Brekke, J. S. (2015). Escape from Discrepancy: Self-Esteem and Quality of Life as Predictors of Current Suicidal Ideation Among Individuals with Schizophrenia. *Community Ment Health J.* doi: 10.1007/s10597-015-9846-8
- Fusar-Poli, P., Papanastasiou, E., Stahl, D., Rocchetti, M., Carpenter, W., Shergill, S., & McGuire, P. (2014). Treatments of Negative Symptoms in Schizophrenia: Meta-Analysis of 168 Randomized Placebo-Controlled Trials. *Schizophr Bull.* doi: 10.1093/schbul/sbu170
- Garcia-Portilla, M. P., Garcia-Alvarez, L., Saiz, P. A., Al-Halabi, S., Bobes-Bascaran, M. T., Bascaran, M. T., . . . Bobes, J. (2015). Psychometric evaluation of the negative syndrome of schizophrenia. *Eur Arch Psychiatry Clin Neurosci.* doi: 10.1007/s00406-015-0595-z
- Gard, D. E., Cooper, S., Fisher, M., Genevsky, A., Mikels, J. A., & Vinogradov, S. (2011). Evidence for an emotion maintenance deficit in schizophrenia. *Psychiatry Research*, 187(1-2), 24-29. doi: 10.1016/j.psychres.2010.12.018
- Gard, D. E., Gard, M. G., Kring, A. M., & John, O. P. (2006). Anticipatory and consummatory components of the experience of pleasure: a scale development study. *Journal of Research in Personality*, 40(6), 1086-1102.
- Gard, D. E., Kring, A. M., Gard, M. G., Horan, W. P., & Green, M. F. (2007). Anhedonia in schizophrenia: distinctions between anticipatory and consummatory pleasure. *Schizophrenia Research*, 93(1-3), 253-260. Epub 2007 May 2009.
- Gard, D. E., Sanchez, A. H., Cooper, K., Fisher, M., Garrett, C., & Vinogradov, S. (2014). Do people with schizophrenia have difficulty anticipating pleasure, engaging in effortful behavior, or both? *Journal of Abnormal Psychology*, 123(4), 771-782. doi: 10.1037/abn0000005
- Gard, D. E., Sanchez, A. H., Starr, J., Cooper, S., Fisher, M., Rowlands, A., & Vinogradov, S. (2014). Using self-determination theory to understand motivation deficits in schizophrenia: the 'why' of motivated behavior. *Schizophr Res*, 156(2-3), 217-222. doi: 10.1016/j.schres.2014.04.027
- Garety, P. A., Kuipers, E., Fowler, D., Freeman, D., & Bebbington, P. E. (2001). A cognitive model of the positive symptoms of psychosis. *Psychol Med*, 31(2), 189-195.
- Gates, N. J., & Kochan, N. A. (2015). Computerized and on-line neuropsychological testing for late-life cognition and neurocognitive disorders: are we there yet? *Curr Opin Psychiatry*, 28(2), 165-172. doi: 10.1097/ycp.0000000000000141
- Geaney, J. T., Treadway, M. T., & Smillie, L. D. (2015). Trait Anticipatory Pleasure Predicts Effort Expenditure for Reward. *PLoS One*, 10(6), e0131357. doi: 10.1371/journal.pone.0131357
- Gelber, E. I., Kohler, C. G., Bilker, W. B., Gur, R. C., Brensinger, C., Siegel, S. J., & Gur, R. E. (2004). Symptom and demographic profiles in first-episode schizophrenia. *Schizophr Res.*, 67(2-3), 185-194.
- Gershuny, J. (2011). Time Use Surveys and the Measurement of National Well-Being. Oxford: Centre for Time Use Research, Department of Sociology, University of Oxford.
- Ghasemi, A., & Zahediasl, S. (2012). Normality Tests for Statistical Analysis: A Guide for Non-Statisticians. *International Journal of Endocrinology and Metabolism*, 10(2), 486-489. doi: 10.5812/ijem.3505
- Gilbert, D. T., & Abdullah, J. (2002). A study of the impact of the expectation of a holiday on an individual's sense of well-being. *Journal of Vacation Marketing*, 8(4), 352-361.

- Gilbert, D. T., & Wilson, T. D. (2007). Prospection: experiencing the future. *Science*, 317(5843), 1351-1354.
- Gold, J. M., Strauss, G. P., Waltz, J. A., Robinson, B. M., Brown, J. K., & Frank, M. J. (2013). Negative symptoms of schizophrenia are associated with abnormal effort-cost computations. *Biol Psychiatry*, 74(2), 130-136. doi: 10.1016/j.biopsych.2012.12.022
- Gold, J. M., Waltz, J. A., Matveeva, T. M., Kasanova, Z., Strauss, G. P., Herbener, E. S., . . . Frank, M. J. (2012). Negative symptoms and the failure to represent the expected reward value of actions: behavioral and computational modeling evidence. *Arch Gen Psychiatry*, 69(2), 129-138. doi: 10.1001/archgenpsychiatry.2011.1269
- Gold, J. M., Waltz, J. A., Prentice, K. J., Morris, S. E., & Heerey, E. A. (2008). Reward processing in schizophrenia: a deficit in the representation of value. *Schizophr Bull.*, 34(5), 835-847. Epub 2008 Jun 2030.
- Goldstein, H., Browne, W., & Rasbash, J. (2002). Partitioning variation in multilevel models. *Understanding Statistics: Statistical Issues in Psychology, Education, and the Social Sciences*, 1(4), 223-231.
- Gorka, S. M., Huggins, A. A., Fitzgerald, D. A., Nelson, B. D., Phan, K. L., & Shankman, S. A. (2014). Neural response to reward anticipation in those with depression with and without panic disorder. *J Affect Disord*, 164, 50-56. doi: 10.1016/j.jad.2014.04.019
- Gotink, R. A., Chu, P., Busschbach, J. J., Benson, H., Fricchione, G. L., & Hunink, M. G. (2015). Standardised mindfulness-based interventions in healthcare: an overview of systematic reviews and meta-analyses of RCTs. *PLoS One*, 10(4), e0124344. doi: 10.1371/journal.pone.0124344
- Gradin, V. B., Kumar, P., Waiter, G., Ahearn, T., Stickle, C., Milders, M., . . . Steele, J. D. (2011). Expected value and prediction error abnormalities in depression and schizophrenia. *Brain.*, 134(Pt 6), 1751-1764. Epub 2011 Apr 1710.
- Granholm, E., Ben-Zeev, D., Fulford, D., & Swendsen, J. (2013). Ecological Momentary Assessment of social functioning in schizophrenia: impact of performance appraisals and affect on social interactions. *Schizophr Res*, 145(1-3), 120-124. doi: 10.1016/j.schres.2013.01.005
- Granholm, E., Loh, C., & Swendsen, J. (2008). Feasibility and validity of computerized ecological momentary assessment in schizophrenia. *Schizophr Bull*, 34(3), 507-514. doi: 10.1093/schbul/sbm113
- Grant, P. M., Huh, G. A., Perivoliotis, D., Stolar, N. M., & Beck, A. T. (2012). Randomized trial to evaluate the efficacy of cognitive therapy for low-functioning patients with schizophrenia. *Arch Gen Psychiatry*, 69(2), 121-127. doi: 10.1001/archgenpsychiatry.2011.1129. Epub 2011 Oct 1003.
- Green, M. F., Horan, W. P., Barch, D. M., & Gold, J. M. (2015). Effort-Based Decision Making: A Novel Approach for Assessing Motivation in Schizophrenia. *Schizophrenia Bulletin*. doi: 10.1093/schbul/sbv071
- Hahn, B., Robinson, B. M., Kaiser, S. T., Harvey, A. N., Beck, V. M., Leonard, C. J., . . . Gold, J. M. (2010). Failure of schizophrenia patients to overcome salient distractors during working memory encoding. *Biol Psychiatry*, 68(7), 603-609. doi: 10.1016/j.biopsych.2010.04.014
- Hammer, M. A., Katsanis, J., & Iacono, W. G. (1995). The relationship between negative symptoms and neuropsychological performance. *Biol Psychiatry*, 37(11), 828-830.
- Hartley, S., Haddock, G., Vasconcelos, E. S. D., Emsley, R., & Barrowclough, C. (2014). An experience sampling study of worry and rumination in psychosis. *Psychol Med*, 44(8), 1605-1614. doi: 10.1017/s0033291713002080
- Hartley, S., Haddock, G., Vasconcelos, E. S. D., Emsley, R., & Barrowclough, C. (2015). The influence of thought control on the experience of persecutory delusions and auditory hallucinations in daily life. *Behav Res Ther*, 65, 1-4. doi: 10.1016/j.brat.2014.12.002
- Hartmann, M. N., Hager, O. M., Reimann, A. V., Chumbley, J. R., Kirschner, M., Seifritz, E., . . . Kaiser, S. (2015). Apathy but not diminished expression in schizophrenia is associated with

- discounting of monetary rewards by physical effort. *Schizophr Bull*, 41(2), 503-512. doi: 10.1093/schbul/sbu102
- Harvey, P. D. (2009). Functional Recovery in Schizophrenia: Raising the Bar for Outcomes in People with Schizophrenia. *Schizophrenia Bulletin*, 35(2), 299-299. doi: 10.1093/schbul/sbn186
- Harvey, P. O., Armony, J., Malla, A., & Lepage, M. (2010). Functional neural substrates of self-reported physical anhedonia in non-clinical individuals and in patients with schizophrenia. *Journal of Psychiatric Research*, 44(11), 707-716. Epub 2010 Jan 2029.
- Harvey, P. O., Bodnar, M., Sergerie, K., Armony, J., & Lepage, M. (2009). Relation between emotional face memory and social anhedonia in schizophrenia. *J Psychiatry Neurosci*, 34(2), 102-110.
- Heerey, E. A., & Gold, J. M. (2007). Patients with schizophrenia demonstrate dissociation between affective experience and motivated behavior. *Journal of Abnormal Psychology*, 116(2), 268-278.
- Heinrichs, R. W., & Zakzanis, K. K. (1998). Neurocognitive deficit in schizophrenia: A quantitative review of the evidence. *Neuropsychology*, 12(3), 426-445. doi: 10.1037/0894-4105.12.3.426
- Heinz, A., Knable, M. B., Coppola, R., Gorey, J. G., Jones, D. W., Lee, K. S., & Weinberger, D. R. (1998). Psychomotor slowing, negative symptoms and dopamine receptor availability--an IBZM SPECT study in neuroleptic-treated and drug-free schizophrenic patients. *Schizophr Res*, 31(1), 19-26.
- Henry, J. D., Von Hippel, C., Ruffman, T. E. D., Perry, Y., & Rendell, P. G. (2010). Threat perception in schizophrenia-spectrum disorders. *Journal of the International Neuropsychological Society*, 16(05), 805-812.
- Herbener, E. S. (2008). Emotional memory in schizophrenia. *Schizophr Bull*, 34(5), 875-887. doi: 10.1093/schbul/sbn081
- Herbener, E. S., Rosen, C., Khine, T., & Sweeney, J. A. (2007). Failure of positive but not negative emotional valence to enhance memory in schizophrenia. *J Abnorm Psychol*, 116(1), 43-55.
- Herbener, E. S., Song, W., Khine, T. T., & Sweeney, J. A. (2008). What aspects of emotional functioning are impaired in schizophrenia? *Schizophr Res*, 98(1-3), 239-246. Epub 2007 Aug 2003.
- Holt, D. V., Wolf, J., Funke, J., Weisbrod, M., & Kaiser, S. (2013). Planning impairments in schizophrenia: specificity, task independence and functional relevance. *Schizophr Res*, 149(1-3), 174-179. doi: 10.1016/j.schres.2013.06.018
- Horan, W. P., Green, M. F., Kring, A. M., & Nuechterlein, K. H. (2006). Does anhedonia in schizophrenia reflect faulty memory for subjectively experienced emotions? *J Abnorm Psychol*, 115(3), 496-508.
- Horan, W. P., Kring, A. M., Gur, R. E., Reise, S. P., & Blanchard, J. J. (2011). Development and psychometric validation of the Clinical Assessment Interview for Negative Symptoms (CAINS). *Schizophr Res*, 132(2-3), 140-145. doi: 10.1016/j.schres.2011.10.06.1030. Epub 2011 Jul 1027.
- Horan, W. P., Wynn, J. K., Kring, A. M., Simons, R. F., & Green, M. F. (2010). Electrophysiological correlates of emotional responding in schizophrenia. *Journal of Abnormal Psychology*, 119(1), 18-30.
- Hui, C., Morcillo, C., Russo, D. A., Stochl, J., Shelley, G. F., Painter, M., . . . Perez, J. (2013). Psychiatric morbidity, functioning and quality of life in young people at clinical high risk for psychosis. *Schizophrenia Research*, 148(1-3), 175-180. doi: <http://dx.doi.org/10.1016/j.schres.2013.05.026>
- Hunot, V., Moore, T. H., Caldwell, D. M., Furukawa, T. A., Davies, P., Jones, H., . . . Churchill, R. (2013). 'Third wave' cognitive and behavioural therapies versus other psychological therapies for depression. *Cochrane Database Syst Rev*, 10, CD008704. doi: 10.1002/14651858.CD008704.pub2
- Hurlburt, R. T., & Melancon, S. M. (1987). "Goofed-up" images: thought sampling with a schizophrenic woman. *J Nerv Ment Dis*, 175(9), 575-578.

- Iwasaki, Y., Coyle, C. P., & Shank, J. W. (2010). Leisure as a context for active living, recovery, health and life quality for persons with mental illness in a global context. *Health Promotion International*, 25(4), 483-494. doi: 10.1093/heapro/daq037
- Jaaskelainen, E., Juola P Fau - Hirvonen, N., Hirvonen N Fau - McGrath, J. J., McGrath Jj Fau - Saha, S., Saha S Fau - Isohanni, M., Isohanni M Fau - Veijola, J., . . . Miettunen, J. (2013). A systematic review and meta-analysis of recovery in schizophrenia. (1745-1701 (Electronic)). doi: D - NLM: PMC3796077 OTO - NOTNLM
- Janssens, M., Lataster, T., Simons, C. J. P., Oorschot, M., Lardinois, M., van Os, J., & Myin-Germeys, I. (2012). Emotion recognition in psychosis: No evidence for an association with real world social functioning. *Schizophrenia Research*, 142(1-3), 116-121. doi: <http://dx.doi.org/10.1016/j.schres.2012.10.003>
- John, J. P., Khanna, S., Thennarasu, K., & Reddy, S. (2003). Exploration of dimensions of psychopathology in neuroleptic-naïve patients with recent-onset schizophrenia/schizophreniform disorder. *Psychiatry Res.*, 121(1), 11-20.
- Jones, M., Kimberlee, R., Deave, T., & Evans, S. (2013). The Role of Community Centre-based Arts, Leisure and Social Activities in Promoting Adult Well-being and Healthy Lifestyles. *International Journal of Environmental Research and Public Health*, 10(5), 1948-1962. doi: 10.3390/ijerph10051948
- Jose, D., Ramachandra, Lalitha, K., Gandhi, S., Desai, G., & Nagarajaiah. (2015). Consumer perspectives on the concept of recovery in schizophrenia: A systematic review. *Asian Journal of Psychiatry*, 14(0), 13-18. doi: <http://dx.doi.org/10.1016/j.ajp.2015.01.006>
- Juckel, G., Schlagenhauf, F., Koslowski, M., Filonov, D., Wustenberg, T., Villringer, A., . . . Heinz, A. (2006). Dysfunction of ventral striatal reward prediction in schizophrenic patients treated with typical, not atypical, neuroleptics. *Psychopharmacology (Berl)*. 187(2), 222-228. Epub 2006 May 2024.
- Juckel, G., Schlagenhauf, F., Koslowski, M., Wustenberg, T., Villringer, A., Knutson, B., . . . Heinz, A. (2006). Dysfunction of ventral striatal reward prediction in schizophrenia. *Neuroimage*, 29(2), 409-416. doi: 10.1016/j.neuroimage.2005.07.051
- Kahl, K. G., Winter, L., & Schweiger, U. (2012). The third wave of cognitive behavioural therapies: what is new and what is effective? *Curr Opin Psychiatry*, 25(6), 522-528. doi: 10.1097/YCO.0b013e328358e531
- Kamath, V., Moberg, P. J., Kohler, C. G., Gur, R. E., & Turetsky, B. I. (2011). Odor Hedonic Capacity and Anhedonia in Schizophrenia and Unaffected First-Degree Relatives of Schizophrenia Patients. *Schizophr Bull*, 26, 26.
- Karatzias, T., Gumley, A., Power, K., & O'Grady, M. (2007). Illness appraisals and self-esteem as correlates of anxiety and affective comorbid disorders in schizophrenia. *Compr Psychiatry*, 48(4), 371-375. doi: 10.1016/j.comppsy.2007.02.005
- Kastner, D., Buchtemann, D., Warnke, I., Radisch, J., Baumgardt, J., Giersberg, S., . . . Rossler, W. (2015). Clinical and functional outcome of assertive outreach for patients with schizophrenic disorder: Results of a quasi-experimental controlled trial. *Eur Psychiatry*. doi: 10.1016/j.eurpsy.2015.04.003
- Kay, S. R., Fiszbein, A., & Opler, L. A. (1987). The positive and negative syndrome scale (PANSS) for schizophrenia. *Schizophr Bull*, 13(2), 261-276.
- Kay, S. R., Opler, L. A., & Lindenmayer, J.-P. (1988). Reliability and validity of the positive and negative syndrome scale for schizophrenics. *Psychiatry Research*, 23(1), 99-110.
- Keefe, R. S. E. (2014). Cognition and motivation as treatment targets in schizophrenia. *JAMA Psychiatry*. doi: 10.1001/jamapsychiatry.2014.1281
- Keefe, R. S. E., Harvey, P. D., Lenzenweger, M. F., Davidson, M., Apter, S. H., Schmeidler, J., . . . Davis, K. L. (1992). Empirical assessment of the factorial structure of clinical symptoms in schizophrenia: Negative symptoms. *Psychiatry Research*, 44(2), 153-165. doi: 10.1016/0165-1781(92)90049-9

- Kemali, D., Maj, M., Galderisi, S., Monteleone, P., & Mucci, A. (1987). Conditional associative learning in drug-free schizophrenic patients. *Neuropsychobiology*, 17(1-2), 30-34.
- Kilian, S., Asmal, L., Goosen, A., Chiliza, B., Phahladira, L., & Emsley, R. (2015). Instruments Measuring Blunted Affect in Schizophrenia: A Systematic Review. *PLoS One*, 10(6), e0127740. doi: 10.1371/journal.pone.0127740
- Kimhy, D., Delespaul, P., Corcoran, C., Ahn, H., Yale, S., & Malaspina, D. (2006). Computerized experience sampling method (ESMc): assessing feasibility and validity among individuals with schizophrenia. *J Psychiatr Res*, 40(3), 221-230. doi: 10.1016/j.jpsychires.2005.09.007
- Kimhy, D., Myin-Germeys, I., Palmier-Claus, J., & Swendsen, J. (2012). Mobile assessment guide for research in schizophrenia and severe mental disorders. *Schizophrenia Bulletin*, 38(3), 386-395.
- Kimhy, D., Vakhrusheva, J., Khan, S., Chang, R. W., Hansen, M. C., Ballon, J. S., . . . Gross, J. J. (2014). Emotional granularity and social functioning in individuals with schizophrenia: An experience sampling study. *Journal of Psychiatric Research*, 53(0), 141-148. doi: <http://dx.doi.org/10.1016/j.jpsychires.2014.01.020>
- Kimhy, D., Vakhrusheva, J., Liu, Y., & Wang, Y. (2014). Use of mobile assessment technologies in inpatient psychiatric settings. *Asian Journal of Psychiatry*, 10(0), 90-95. doi: <http://dx.doi.org/10.1016/j.ajp.2014.04.004>
- Kirkbride, J. B., Boydell, J., Ploubidis, G. B., Morgan, C., Dazzan, P., McKenzie, K., . . . Jones, P. B. (2008). Testing the association between the incidence of schizophrenia and social capital in an urban area. *Psychol Med*, 38(8), 1083-1094. doi: 10.1017/s0033291707002085
- Kirkpatrick, B. (2014). Developing concepts in negative symptoms: primary vs secondary and apathy vs expression. *J Clin Psychiatry*, 75 Suppl 1, 3-7. doi: 10.4088/JCP.13049su1c.01
- Kirkpatrick, B., Fenton, W. S., Carpenter, W. T., Jr., & Marder, S. R. (2006). The NIMH-MATRICES consensus statement on negative symptoms. *Schizophrenia Bulletin*, 32(2), 214-219. Epub 2006 Feb 2015.
- Kirkpatrick, B., Strauss, G. P., Nguyen, L., Fischer, B. A., Daniel, D. G., Cienfuegos, A., & Marder, S. R. (2011). The brief negative symptom scale: psychometric properties. *Schizophr Bull.*, 37(2), 300-305. Epub 2010 Jun 2017.
- Kirsch, P., Ronshausen, S., Mier, D., & Gallhofer, B. (2007). The influence of antipsychotic treatment on brain reward system reactivity in schizophrenia patients. *Pharmacopsychiatry*, 40(5), 196-198. doi: 10.1055/s-2007-984463
- Knutson, B., Fong, G. W., Adams, C. M., Varner, J. L., & Hommer, D. (2001). Dissociation of reward anticipation and outcome with event-related fMRI. *Neuroreport*, 12(17), 3683-3687.
- Kollias, C. T., Kontaxakis, V. P., Havaki-Kontaxaki, B. J., Stamouli, S., Margariti, M., & Petridou, E. (2008). Association of physical and social anhedonia with depression in the acute phase of schizophrenia. *Psychopathology*, 41(6), 365-370. Epub 2008 Sep 2003.
- Kraepelin, E. (1971/1919). *Dementia praecox and paraphrenia* (1919). Translated by Barclay RM; edited by Robertson GM: New York, Robert E Krieger.
- Kraepelin, E. (1981/1904). *Clinical Psychiatry (Introduction by E.T. Carlson)*. Delmar, NY (original work published in 1904): Scholar's Facismiles and Reprints.
- Kring, A. M., & Barch, D. M. (2014). The motivation and pleasure dimension of negative symptoms: Neural substrates and behavioral outputs. *European Neuropsychopharmacology*, 24(5), 725-736. doi: <http://dx.doi.org/10.1016/j.euroneuro.2013.06.007>
- Kring, A. M., & Caponigro, J. M. (2010). Emotion in Schizophrenia Where Feeling Meets Thinking. *Current Directions in Psychological Science*, 19(4), 255-259.
- Kring, A. M., Germans Gard, M., & Gard, D. E. (2011). Emotion deficits in schizophrenia: timing matters. *Journal of Abnormal Psychology*, 120(1), 79-87. doi: 10.1037/a0021402
- Kring, A. M., Gur, R. E., Blanchard, J. J., Horan, W. P., & Reise, S. P. (2013). The Clinical Assessment Interview for Negative Symptoms (CAINS): final development and validation. *Am J Psychiatry*, 170(2), 165-172. doi: 10.1176/appi.ajp.2012.12010109

- Kring, A. M., Kerr, S. L., Smith, D. A., & Neale, J. M. (1993). Flat affect in schizophrenia does not reflect diminished subjective experience of emotion. *J Abnorm Psychol.*, 102(4), 507-517.
- Lacerda, A. L., Hardan, A. Y., Yorbik, O., Vemulapalli, M., Prasad, K. M., & Keshavan, M. S. (2007). Morphology of the orbitofrontal cortex in first-episode schizophrenia: relationship with negative symptomatology. *Prog Neuropsychopharmacol Biol Psychiatry.*, 31(2), 510-516. Epub 2007 Jan 2018.
- Lader, D., Short, S., & Gershuny, J. (2006). The time use survey, 2005. *How we spend our time.* London: Office for National Statistics.[online].< URL: <http://www.timeuse.org/information/publications/docs/TimeUse2005.pdf>>. *Luettu*, 15, 2009.
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999a). International affective picture system (IAPS): instruction manual and affective ratings. *The Center for Research in Psychophysiology, University of Florida.*
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999b). International affective picture system (IAPS): technical manual and affective ratings: Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8. . Gainesville, FL. .
- Lang, P. J., Greenwald, M. K., Bradley, M. M., & Cuthbert, B. N. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology*, 30(3), 261-273.
- Larquet, M., Coricelli, G., Opolczynski, G., & Thibaut, F. (2010). Impaired decision making in schizophrenia and orbitofrontal cortex lesion patients. *Schizophr Res.*, 116(2-3), 266-273.
- Larson, M. J., Gray, A. C., Clayson, P. E., Jones, R., & Kirwan, C. B. (2013). What are the influences of orthogonally-manipulated valence and arousal on performance monitoring processes? The effects of affective state. *International Journal of Psychophysiology*, 87(3), 327-339. doi: <http://dx.doi.org/10.1016/j.ijpsycho.2013.01.005>
- Lataster, J., van Os, J., de Haan, L., Thewissen, V., Bak, M., Lataster, T., . . . Myin-Germeys, I. (2011). Emotional experience and estimates of D2 receptor occupancy in psychotic patients treated with haloperidol, risperidone, or olanzapine: an experience sampling study. *J Clin Psychiatry*, 72(10), 1397-1404. doi: 10.4088/JCP.09m05466yel
- Laurent, A., Biloa-Tang, M., Bougerol, T., Duly, D., Anchisi, A. M., Bosson, J. L., . . . Dalery, J. (2000). Executive/attentional performance and measures of schizotypy in patients with schizophrenia and in their nonpsychotic first-degree relatives. *Schizophr Res.*, 46(2-3), 269-283.
- Lee, E., Kim, J. J., Namkoong, K., An, S. K., Seok, J. H., Lee, Y. J., . . . Lee, H. S. (2006). Aberrantly flattened responsivity to emotional pictures in paranoid schizophrenia. *Psychiatry Res.*, 143(2-3), 135-145. Epub 2006 Aug 2001.
- Lee, H., Shackman, A. J., Jackson, D. C., & Davidson, R. J. (2009). Test-retest reliability of voluntary emotion regulation. *Psychophysiology*, 46(4), 874-879. doi: 10.1111/j.1469-8986.2009.00830.x
- Lee, J. S., Chun, J. W., In Kang, J., Kang, D. I., Park, H. J., & Kim, J. J. (2012). Hippocampus and nucleus accumbens activity during neutral word recognition related to trait physical anhedonia in patients with schizophrenia: An fMRI study. *Psychiatry Res.*, 203(1), 46-53. doi: 10.1016/j.psychres.2011.1009.1004. Epub 2012 Aug 2014.
- Lee, T. Y., Hong, S. B., Shin, N. Y., & Kwon, J. S. (2015). Social cognitive functioning in prodromal psychosis: A meta-analysis. *Schizophrenia Research*, 164(1-3), 28-34. doi: <http://dx.doi.org/10.1016/j.schres.2015.02.008>
- Lewinsohn, P. M., Friedman, R. J., & Katz, M. M. (1974). A behavioral approach to depression. *The psychology of depression: Contemporary theory and research* (pp. 157-185). Washington, DC: Winston-Wile.
- Lewinsohn, P. M., & Graf, M. (1973). Pleasant activities and depression. *J Consult Clin Psychol*, 41(2), 261-268.

- Lewinsohn, P. M., & Libet, J. (1972). Pleasant events, activity schedules, and depressions. *Journal of Abnormal Psychology*, 79(3), 291-295.
- Li, Z., Lui, S. S. Y., Geng, F.-l., Li, Y., Li, W.-x., Wang, C.-y., . . . Chan, R. C. K. (2015). Experiential pleasure deficits in different stages of schizophrenia. *Schizophrenia Research*(0). doi: <http://dx.doi.org/10.1016/j.schres.2015.05.041>
- Lieberman, J. A., Stroup, T. S., McEvoy, J. P., Swartz, M. S., Rosenheck, R. A., Perkins, D. O., . . . Hsiao, J. K. (2005). Effectiveness of Antipsychotic Drugs in Patients with Chronic Schizophrenia. *New England Journal of Medicine*, 353(12), 1209-1223. doi: 10.1056/NEJMoa051688
- Liemburg, E., Castelein, S., Stewart, R., van der Gaag, M., Aleman, A., & Knegtering, H. (2013). Two subdomains of negative symptoms in psychotic disorders: Established and confirmed in two large cohorts. *Journal of Psychiatric Research*, 47(6), 718-725. doi: <http://dx.doi.org/10.1016/j.jpsychires.2013.01.024>
- Lindenmayer, J. P., Grochowski, S., & Hyman, R. B. (1995). Five factor model of schizophrenia: replication across samples. *Schizophr Res*, 14(3), 229-234.
- Llerena, K., Strauss, G. P., & Cohen, A. S. (2012). Looking at the other side of the coin: a meta-analysis of self-reported emotional arousal in people with schizophrenia. *Schizophr Res*, 142(1-3), 65-70. doi: 10.1016/j.schres.2012.09.005
- Loas, G., Azi, A., Noisette, C., Legrand, A., & Yon, V. (2009). Fourteen-year prospective follow-up study of positive and negative symptoms in chronic schizophrenic patients dying from suicide compared to other causes of death. *Psychopathology*, 42(3), 185-189. Epub 2009 Mar 2027.
- Loas, G., Duru, C., Godefroy, O., & Krystkowiak, P. (2014). Hedonic deficits in Parkinson's disease: is consummatory anhedonia specific? *Front Neurol*, 5, 24. doi: 10.3389/fneur.2014.00024
- Loas, G., Monestes, J. L., Ingelaere, A., Noisette, C., & Herbener, E. S. (2009). Stability and relationships between trait or state anhedonia and schizophrenic symptoms in schizophrenia: a 13-year follow-up study. *Psychiatry Res.*, 166(2-3), 132-140. Epub 2009 Mar 2009.
- Lowengrub, K. M., Stryjer, R., Birger, M., & Iancu, I. (2015). Social Anxiety Disorder Comorbid with Schizophrenia: The Importance of Screening for This Under recognized and Under treated Condition. *Isr J Psychiatry Relat Sci*, 52(1), 40-45.
- Luck, S. J., & Gold, J. M. (2008). The construct of attention in schizophrenia. *Biol Psychiatry*, 64(1), 34-39. doi: 10.1016/j.biopsych.2008.02.014
- Lyne, J., Renwick, L., Grant, T., Kinsella, A., McCarthy, P., Malone, K., . . . Clarke, M. (2013). Scale for the Assessment of Negative Symptoms structure in first episode psychosis. *Psychiatry Res*, 210(3), 1191-1197. doi: 10.1016/j.psychres.2013.09.008
- Lysaker, P. H., Leonhardt, B. L., Brüne, M., Buck, K. D., James, A., Vohs, J., . . . Dimaggio, G. (2014). Capacities for theory of mind, metacognition, and neurocognitive function are independently related to emotional recognition in schizophrenia. *Psychiatry Research*(0). doi: <http://dx.doi.org/10.1016/j.psychres.2014.05.004>
- Maastricht University. PsyMate: Insight into Daily Moods. from <http://www.psymate.eu/>
- Maeda, T., Takahata, K., Muramatsu, T., Okimura, T., Koreki, A., Iwashita, S., . . . Kato, M. (2013). Reduced sense of agency in chronic schizophrenia with predominant negative symptoms. *Psychiatry Res*, 209(3), 386-392. doi: 10.1016/j.psychres.2013.04.017
- Malaspina, D., Walsh-Messinger, J., Gaebel, W., Smith, L. M., Gorun, A., Prudent, V., . . . Trémeau, F. (2014). Negative symptoms, past and present: A historical perspective and moving to DSM-5. *European Neuropsychopharmacology*, 24(5), 710-724. doi: 10.1016/j.euroneuro.2013.10.018
- Marchesi, C., Affaticati, A., Monici, A., De Panfilis, C., Ossola, P., Ottoni, R., & Tonna, M. (2015). Decrease of Functioning in Remitted and Non-Remitted Patients 16 Years After a First-Episode Schizophrenia. *J Nerv Ment Dis*. doi: 10.1097/nmd.0000000000000299

- Matsuzawa, D., Shirayama, Y., Niitsu, T., Hashimoto, K., & Iyo, M. (2015). Deficits in emotion based decision-making in schizophrenia; a new insight based on the Iowa Gambling Task. *Prog Neuropsychopharmacol Biol Psychiatry*, 57, 52-59. doi: 10.1016/j.pnpbp.2014.10.007
- McCormick, B. P., Snethen, G., & Lysaker, P. H. (2012). Emotional episodes in the everyday lives of people with schizophrenia: the role of intrinsic motivation and negative symptoms. *Schizophr Res*, 142(1-3), 46-51. doi: 10.1016/j.schres.2012.09.002
- Medalia, A., & Saperstein, A. M. (2013). Does cognitive remediation for schizophrenia improve functional outcomes? *Curr Opin Psychiatry*, 26(2), 151-157. doi: 10.1097/YCO.0b013e32835dcdbd4
- Menendez-Miranda, I., Garcia-Portilla, M. P., Garcia-Alvarez, L., Arrojo, M., Sanchez, P., Sarramea, F., . . . Bobes, J. (2015). Predictive factors of functional capacity and real-world functioning in patients with schizophrenia. *Eur Psychiatry*. doi: 10.1016/j.eurpsy.2014.12.011
- Messinger, J. W., Trémeau, F., Antonius, D., Mendelsohn, E., Prudent, V., Stanford, A. D., & Malaspina, D. (2011). Avolition and expressive deficits capture negative symptom phenomenology: implications for DSM-5 and schizophrenia research. *Clin Psychol Rev*, 31(1), 161-168. doi: 10.1016/j.cpr.2010.09.002
- Moe, A. M., & Docherty, N. M. (2014). Schizophrenia and the sense of self. *Schizophr Bull*, 40(1), 161-168. doi: 10.1093/schbul/sbt121
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The Prisma Group. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med*, 6(7), e1000097. doi: 10.1371/journal.pmed.1000097
- Morrens, M., Hulstijn, W., & Sabbe, B. (2007). Psychomotor Slowing in Schizophrenia. *Schizophrenia Bulletin*, 33(4), 1038-1053. doi: 10.1093/schbul/sbl051
- Morris, R. W., Vercammen, A., Lenroot, R., Moore, L., Langton, J. M., Short, B., . . . Weickert, T. W. (2012). Disambiguating ventral striatum fMRI-related BOLD signal during reward prediction in schizophrenia. *Mol Psychiatry*, 17(3), 235, 280-239. doi: 10.1038/mp.2011.75
- Mosolov, S. N., Potapov, A. V., Ushakov, U. V., Shafarenko, A. A., & Kostyukova, A. B. (2014). Design and validation of standardized clinical and functional remission criteria in schizophrenia. *Neuropsychiatr Dis Treat*, 10, 167-181. doi: 10.2147/ndt.s46799
- Mote, J., Minzenberg, M. J., Carter, C. S., & Kring, A. M. (2014). Deficits in anticipatory but not consummatory pleasure in people with recent-onset schizophrenia spectrum disorders. *Schizophrenia Research*, 159(1), 76-79. doi: 10.1016/j.schres.2014.07.048
- Mucci, A., Dima, D., Soricelli, A., Volpe, U., Bucci, P., Frangou, S., . . . Maj, M. (2015). Is avolition in schizophrenia associated with a deficit of dorsal caudate activity? A functional magnetic resonance imaging study during reward anticipation and feedback. *Psychol Med*, 1-14. doi: 10.1017/s0033291714002943
- Mueller, D. R., Schmidt, S. J., & Roder, V. (2015). One-year randomized controlled trial and follow-up of integrated neurocognitive therapy for schizophrenia outpatients. *Schizophr Bull*, 41(3), 604-616. doi: 10.1093/schbul/sbu223
- Mueser, K. T., Sayers, S. L., Schooler, N. R., Mance, R. M., & Haas, G. L. (1994). A multisite investigation of the reliability of the Scale for the Assessment of Negative Symptoms. *Am J Psychiatry*, 151(10), 1453-1462.
- Murray, C. J. L., & Lopez, A. D. (1996). The Global Burden of Disease: a comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990 and projected to 2020. *Global Burden of Disease and Injury Series* (Vol. 1): Cambridge, MA, Harvard School of Public Health.
- Murray, G. K., Corlett, P. R., Clark, L., Pessiglione, M., Blackwell, A. D., Honey, G., . . . Fletcher, P. C. (2008). Substantia nigra/ventral tegmental reward prediction error disruption in psychosis. *Mol Psychiatry*, 13(3), 239, 267-276. doi: 10.1038/sj.mp.4002058
- Myin-Germeyns, I., Delespaul, P., & deVries, M. W. (2000). Schizophrenia patients are more emotionally active than is assumed based on their behavior. *Schizophr Bull*, 26(4), 847-854.

- Myin-Germeys, I., Krabbendam, L., Delespaul, P., & van Os, J. (2004). Sex differences in emotional reactivity to daily life stress in psychosis. *J Clin Psychiatry*, 65(6), 805-809.
- National Institute for Health and Care Excellence (NICE). (2014). NICE Guidelines. from <https://www.nice.org.uk/guidance/cg178>
- Nawijn, J., Marchand, M., Veenhoven, R., & Vingerhoets, A. (2010). Vacationers Happier, but Most not Happier After a Holiday. *Applied Research in Quality of Life*, 5(1), 35-47. doi: 10.1007/s11482-009-9091-9
- Nicholson, I. R., Chapman, J. E., & Neufeld, R. W. (1995). Variability in BPRS definitions of positive and negative symptoms. *Schizophr Res*, 17(2), 177-185.
- Noble, W. S. (2009). How does multiple testing correction work? *Nature biotechnology*, 27(12), 1135-1137. doi: 10.1038/nbt1209-1135
- Ohtani, T., Bouix, S., Hosokawa, T., Saito, Y., Eckbo, R., Ballinger, T., . . . Kubicki, M. (2014). Abnormalities in white matter connections between orbitofrontal cortex and anterior cingulate cortex and their associations with negative symptoms in schizophrenia: A DTI study. *Schizophr Res*, 157(1-3), 190-197. doi: 10.1016/j.schres.2014.05.016
- Oorschot, M., Kwapiil, T., Delespaul, P., & Myin-Germeys, I. (2009). Momentary assessment research in psychosis. *Psychol Assess*, 21(4), 498-505. doi: 10.1037/a0017077
- Oorschot, M., Lataster, T., Thewissen, V., Lardinois, M., van Os, J., Delespaul, P., & Myin-Germeys, I. (2012). Symptomatic remission in psychosis and real-life functioning. *Br J Psychiatry*, 201(3), 215-220. doi: 10.1192/bjp.bp.111.104414
- Oorschot, M., Lataster, T., Thewissen, V., Lardinois, M., Wichers, M., van Os, J., . . . Myin-Germeys, I. (2013). Emotional Experience in Negative Symptoms of Schizophrenia--No Evidence for a Generalized Hedonic Deficit. *Schizophrenia Bulletin*, 20, 20.
- Overall, J. E., & Gorham, D. R. (1962). The brief psychiatric rating scale. *Psychological Reports*, 10(3), 799-812.
- Palmier-Claus, J. E., Ainsworth, J., Machin, M., Barrowclough, C., Dunn, G., Barkus, E., . . . Lewis, S. W. (2012). The feasibility and validity of ambulatory self-report of psychotic symptoms using a smartphone software application. *BMC Psychiatry*, 12, 172. doi: 10.1186/1471-244x-12-172
- Palmier-Claus, J. E., Myin-Germeys, I., Barkus, E., Bentley, L., Udachina, A., Delespaul, P., . . . Dunn, G. (2011). Experience sampling research in individuals with mental illness: reflections and guidance. *Acta Psychiatr Scand*, 123(1), 12-20. doi: 10.1111/j.1600-0447.2010.01596.x
- Park, I. H., Chun, J. W., Park, H.-J., Koo, M.-S., Park, S., Kim, S.-H., & Kim, J.-J. (2015). Altered cingulo-striatal function underlies reward drive deficits in schizophrenia. *Schizophrenia Research*, 161(2-3), 229-236. doi: <http://dx.doi.org/10.1016/j.schres.2014.11.005>
- Park, I. H., Kim, J. J., Chun, J., Jung, Y. C., Seok, J. H., Park, H. J., & Lee, J. D. (2009). Medial prefrontal default-mode hypoactivity affecting trait physical anhedonia in schizophrenia. *Psychiatry Res.*, 171(3), 155-165. Epub 2009 Feb 2013.
- Park, K. M., Kim, J. J., Seok, J. H., Chun, J. W., Park, H. J., & Lee, J. D. (2009). Anhedonia and ambivalence in schizophrenic patients with fronto-cerebellar metabolic abnormalities: a fluoro-d-glucose positron emission tomography study. *Psychiatry Investig.*, 6(2), 72-77. Epub 2009 Jun 2030.
- Park, S. G., Llerena, K., McCarthy, J. M., Couture, S. M., Bennett, M. E., & Blanchard, J. J. (2012). Screening for negative symptoms: preliminary results from the self-report version of the Clinical Assessment Interview for Negative Symptoms. *Schizophr Res.*, 135(1-3), 139-143. Epub 2012 Jan 2021.
- Perala, J., Suvisaari, J., Saarni, S. I., Kuoppasalmi, K., Isometsa, E., Pirkola, S., . . . Lonnqvist, J. (2007). Lifetime prevalence of psychotic and bipolar I disorders in a general population. *Arch Gen Psychiatry*, 64(1), 19-28. doi: 10.1001/archpsyc.64.1.19
- Pinkham, A. E., Sasson, N. J., Kelsven, S., Simpson, C. E., Healey, K., & Kohler, C. (2014). An intact threat superiority effect for nonsocial but not social stimuli in schizophrenia. *Journal of Abnormal Psychology*, 123(1), 168-177. doi: 10.1037/a0035639

- Plailly, J., d'Amato, T., Saoud, M., & Royet, J. P. (2006). Left temporo-limbic and orbital dysfunction in schizophrenia during odor familiarity and hedonicity judgments. *Neuroimage.*, 29(1), 302-313. Epub 2005 Aug 2011.
- Posner, J., Russell, J. A., & Peterson, B. S. (2005). The circumplex model of affect: An integrative approach to affective neuroscience, cognitive development, and psychopathology. *Development and Psychopathology*, 17(3), 715-734. doi: 10.1017/S0954579405050340
- Priebe, S., Savill, M., Reininghaus, U., Wykes, T., Bentall, R., Lauber, C., . . . Eldridge, S. (2013). Effectiveness and cost-effectiveness of body psychotherapy in the treatment of negative symptoms of schizophrenia--a multi-centre randomised controlled trial. *BMC Psychiatry*, 13, 26. doi: 10.1186/1471-244x-13-26
- Quinlan, T., Roesch, S., & Granholm, E. (2014). The role of dysfunctional attitudes in models of negative symptoms and functioning in schizophrenia. *Schizophr Res*, 157(1-3), 182-189. doi: 10.1016/j.schres.2014.05.025
- Quirk, S. W., Strauss, M. E., & Sloan, D. M. (1998). Emotional response as a function of symptoms in schizophrenia. *Schizophr Res*, 32(1), 31-39.
- Radke, S., Pfersmann, V., & Derntl, B. (2015). The impact of emotional faces on social motivation in schizophrenia. *Eur Arch Psychiatry Clin Neurosci*. doi: 10.1007/s00406-015-0589-x
- Rassovsky, Y., Horan, W. P., Lee, J., Sergi, M. J., & Green, M. F. (2011). Pathways between early visual processing and functional outcome in schizophrenia. *Psychol Med.*, 41(3), 487-497. Epub 2010 May 2019.
- Rathod, S., Kingdon, D., Weiden, P., & Turkington, D. (2008). Cognitive-behavioral therapy for medication-resistant schizophrenia: a review. *J Psychiatr Pract*, 14(1), 22-33. doi: 10.1097/01.pra.0000308492.93003.db
- Reddy, F. L., Green, M. F., Rizzo, S., Sugar, C. A., Blanchard, J. J., Gur, R. E., . . . Horan, W. P. (2014). Behavioral approach and avoidance in schizophrenia: An evaluation of motivational profiles. *Schizophrenia Research*(0). doi: <http://dx.doi.org/10.1016/j.schres.2014.07.047>
- Reichenberg, A. (2010). The assessment of neuropsychological functioning in schizophrenia. *Dialogues Clin Neurosci*, 12(3), 383-392.
- Reichenberg, A., Feo, C., Prestia, D., Bowie, C. R., Patterson, T. L., & Harvey, P. D. (2014). The Course and Correlates of Everyday Functioning in Schizophrenia. *Schizophr Res Cogn*, 1(1), e47-e52. doi: 10.1016/j.scog.2014.03.001
- Rethelyi, J. M., Czobor, P., Polgar, P., Mersich, B., Balint, S., Jekkel, E., . . . Bitter, I. (2012). General and domain-specific neurocognitive impairments in deficit and non-deficit schizophrenia. *Eur Arch Psychiatry Clin Neurosci*, 262(2), 107-115. doi: 10.1007/s00406-011-0224-4
- Reynolds, J. R. (1861). *Epilepsy: Its symptoms, treatment, and relation to other chronic convulsive diseases*. . London, UK: John Churchill
- Ritsner, M. S. (2013). Anhedonia of patients with schizophrenia and schizoaffective disorder is attributed to personality-related factors rather than to state-dependent clinical symptoms. *Clin Schizophr Relat Psychoses*, 1-32. doi: 10.3371/psrp.ri.031513
- Roberts, D. L., Combs, D. R., Willoughby, M., Mintz, J., Gibson, C., Rupp, B., & Penn, D. L. (2014). A randomized, controlled trial of Social Cognition and Interaction Training (SCIT) for outpatients with schizophrenia spectrum disorders. *Br J Clin Psychol*, 53(3), 281-298. doi: 10.1111/bjc.12044
- Robertson, B. R., Prestia, D., Twamley, E. W., Patterson, T. L., Bowie, C. R., & Harvey, P. D. (2014). Social competence versus negative symptoms as predictors of real world social functioning in schizophrenia. *Schizophr Res*, 160(1-3), 136-141. doi: 10.1016/j.schres.2014.10.037
- Robinson, M. D., & Clore, G. L. (2002). Belief and feeling: evidence for an accessibility model of emotional self-report. *Psychol Bull*, 128(6), 934-960.
- Rocca, P., Montemagni, C., Zappia, S., Piterà, R., Sigauco, M., & Bogetto, F. (2014). Negative symptoms and everyday functioning in schizophrenia: a cross-sectional study in a real world-

- setting. *Psychiatry Research*, 218(3), 284-289. doi: <http://dx.doi.org/10.1016/j.psychres.2014.04.018>
- Roder, V., Mueller, D. R., Brenner, H. D., & Spaulding, W. (2010). *Integrated Psychological Therapy (IPT) for the Treatment of Neurocognition, Social Cognition and Social Competency in Schizophrenia Patients*. Seattle, WA: Hogrefe & Huber.
- Roder, V., Mueller, D. R., & Schmidt, S. J. (2011). Effectiveness of integrated psychological therapy (IPT) for schizophrenia patients: a research update. *Schizophr Bull*, 37 Suppl 2, S71-79. doi: 10.1093/schbul/sbr072
- Romney, D. M., & Candido, C. L. (2001). Anhedonia in Depression and Schizophrenia: A Reexamination. *Journal of Nervous & Mental Disease November*, 189(11), 735-740.
- Rose, D. (2014). The mainstreaming of recovery. *J Ment Health*, 23(5), 217-218. doi: 10.3109/09638237.2014.928406
- Rose, D., & Wykes, T. (2001). Service User Research Enterprise. from <http://www.kcl.ac.uk/ioppn/depts/hspr/research/ciemh/sure/index.aspx>
- Rosenheck, R., Leslie, D., Keefe, R., McEvoy, J., Swartz, M., Perkins, D., . . . Lieberman, J. (2006). Barriers to employment for people with schizophrenia. *Am J Psychiatry*, 163(3), 411-417. doi: 10.1176/appi.ajp.163.3.411
- Roux, P., Christophe, A., & Passerieux, C. (2010). The emotional paradox: dissociation between explicit and implicit processing of emotional prosody in schizophrenia. *Neuropsychologia*, 48(12), 3642-3649. Epub 2010 Aug 3627.
- Royston, P. (1992). Approximating the Shapiro-Wilk W-test for non-normality. *Statistics and Computing*, 2(3), 117-119. doi: 10.1007/BF01891203
- Russell, J. A. (1980). A circumplex model of affect. *Journal of personality and social psychology*, 39, 1161-1178.
- Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am Psychol*, 55(1), 68-78.
- Salvatore, G., Lysaker, P. H., Gumley, A., Popolo, R., Mari, J., & Dimaggio, G. (2012). Out of illness experience: metacognition-oriented therapy for promoting self-awareness in individuals with psychosis. *Am J Psychother*, 66(1), 85-106.
- Sanchez, A. H., Lavaysse, L. M., Starr, J. N., & Gard, D. E. (2014). Daily life evidence of environment-incongruent emotion in schizophrenia. *Psychiatry Res*, 220(1-2), 89-95. doi: 10.1016/j.psychres.2014.07.041
- Saperstein, A. M., Fiszdon, J. M., & Bell, M. D. (2011). Intrinsic motivation as a predictor of work outcome after vocational rehabilitation in schizophrenia. *J Nerv Ment Dis*, 199(9), 672-677. doi: 10.1097/NMD.0b013e318229d0eb
- Sarin, F., & Wallin, L. (2014). Cognitive model and cognitive behavior therapy for schizophrenia: an overview. *Nord J Psychiatry*, 68(3), 145-153. doi: 10.3109/08039488.2013.789074
- Sarkar, S., Praharaj, S. K., Chaudhury, S., & Das, B. (2010). Anhedonia in acute schizophrenia. *Afr J Psychiatry (Johannesbg)*, 13(3), 226-227.
- Savla, G. N., Vella, L., Armstrong, C. C., Penn, D. L., & Twamley, E. W. (2013). Deficits in Domains of Social Cognition in Schizophrenia: A Meta-Analysis of the Empirical Evidence. *Schizophrenia Bulletin*, 39(5), 979-992.
- Sax, K. W., Strakowski, S. M., Keck, P. E., Jr., Upadhyaya, V. H., West, S. A., & McElroy, S. L. (1996). Relationships among negative, positive, and depressive symptoms in schizophrenia and psychotic depression. *Br J Psychiatry*, 168(1), 68-71.
- Schaefer, J., Giangrande, E., Weinberger, D. R., & Dickinson, D. (2013). The global cognitive impairment in schizophrenia: Consistent over decades and around the world. *Schizophrenia Research*, 150(1), 42-50. doi: 10.1016/j.schres.2013.07.009
- Schennach, R., Riedel, M., Obermeier, M., Seemuller, F., Jager, M., Schmauss, M., . . . Moller, H. J. (2015). What are depressive symptoms in acutely ill patients with schizophrenia spectrum disorder? *Eur Psychiatry*, 30(1), 43-50. doi: 10.1016/j.eurpsy.2014.11.001

- Schlagenhauf, F., Juckel, G., Koslowski, M., Kahnt, T., Knutson, B., Dembler, T., . . . Heinz, A. (2008). Reward system activation in schizophrenic patients switched from typical neuroleptics to olanzapine. *Psychopharmacology (Berl)*, 196(4), 673-684. Epub 2007 Dec 2021.
- Schlenker, R., Cohen, R., & Hopmann, G. (1995). Affective modulation of the startle reflex in schizophrenic patients. *Eur Arch Psychiatry Clin Neurosci*, 245(6), 309-318.
- Schlosser, D. A., Fisher, M., Gard, D. E., Fulford, D., Loewy, R. L., & Vinogradov, S. (2014). Motivational deficits in individuals at-risk for psychosis and across the course of schizophrenia. *Schizophr Res*. doi: 10.1016/j.schres.2014.06.024
- Schmidt, K., Nolte-Zenker, B., Patzer, J., Bauer, M., Schmidt, L. G., & Heinz, A. (2001). Psychopathological correlates of reduced dopamine receptor sensitivity in depression, schizophrenia, and opiate and alcohol dependence. *Pharmacopsychiatry*, 34(2), 66-72.
- Schneider, F., Gur, R. C., Gur, R. E., & Shtasel, D. L. (1995). Emotional processing in schizophrenia: neurobehavioral probes in relation to psychopathology. *Schizophr Res*, 17(1), 67-75.
- Schneider, K. (1959). *Clinical psychopathology*. New York, NY: Grune & Stratton.
- Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E., . . . Dunbar, G. C. (1998). The Mini-International Neuropsychiatric Interview (MINI): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *Journal of clinical psychiatry*, 59, 22-33.
- Sherdell, L., Waugh, C. E., & Gotlib, I. H. (2012). Anticipatory pleasure predicts motivation for reward in major depression. *Journal of Abnormal Psychology*, 121(1), 51-60. doi: 10.1037/a0024945
- Short, S. (2006). Review of the UK 2000 Time Use Survey. London.
- Silverstein, S. M. (2008). Measuring specific, rather than generalized, cognitive deficits and maximizing between-group effect size in studies of cognition and cognitive change. *Schizophr Bull*, 34(4), 645-655. doi: 10.1093/schbul/sbn032
- Simon, J. J., Biller, A., Walther, S., Roesch-Ely, D., Stippich, C., Weisbrod, M., & Kaiser, S. (2010). Neural correlates of reward processing in schizophrenia--relationship to apathy and depression. *Schizophr Res*, 118(1-3), 154-161. Epub 2009 Dec 2016.
- Skolnick, A. I., & Davidson, R. I. (2002). Affective modulation of eyeblink startle with reward and threat. *Psychophysiology*, 39(6), 835-850.
- Smith, D. (2014, October 15th). This Is What Developing Acute Schizophrenia Feels Like *Vice*.
- Snaith, R. P., Hamilton, M., Morley, S., Humayan, A., Hargreaves, D., & Trigwell, P. (1995). A scale for the assessment of hedonic tone the Snaith-Hamilton Pleasure Scale. *Br J Psychiatry*, 167(1), 99-103.
- Snezhnevsky, A. (1968). *The Symptomatology, Clinical Forms and Nosology of Schizophrenia* New York, NY: Brunner-Mazel.
- Spitzer, R. L., Endicott, J., & Robins, E. (1978). Research diagnostic criteria: rationale and reliability. *Arch Gen Psychiatry*, 35(6), 773-782.
- SPSS Inc. (2012). IBM SPSS Statistics for Windows. Armonk, NY. : IBM Corp. .
- StataCorp. (2009). Stata Statistical Software: Release 11. College Station, TX: StataCorp LP.
- Stevens, A., Schwarz, J., Schwarz, B., Ruf, I., Kolter, T., & Czekalla, J. (2002). Implicit and explicit learning in schizophrenics treated with olanzapine and with classic neuroleptics. *Psychopharmacology (Berl)*. 160(3), 299-306. Epub 2002 Feb 2007.
- Strauss, G. P. (2013a). The Emotion Paradox of Anhedonia in Schizophrenia: Or Is It? *Schizophrenia Bulletin*. doi: 10.1093/schbul/sbs192
- Strauss, G. P. (2013b). Translating Basic Emotion Research Into Novel Psychosocial Interventions for Anhedonia. *Schizophrenia Bulletin*, 39(4), 737-739.
- Strauss, G. P., Frank, M. J., Waltz, J. A., Kasanova, Z., Herbener, E. S., & Gold, J. M. (2011). Deficits in Positive Reinforcement Learning and Uncertainty-Driven Exploration Are Associated with Distinct Aspects of Negative Symptoms in Schizophrenia. *Biological Psychiatry*, 69(5), 424-431. doi: <http://dx.doi.org/10.1016/j.biopsych.2010.10.015>

- Strauss, G. P., & Gold, J. M. (2012). A new perspective on anhedonia in schizophrenia. *Am J Psychiatry*, 169(4), 364-373.
- Strauss, G. P., & Herbener, E. S. (2011). Patterns of emotional experience in schizophrenia: differences in emotional response to visual stimuli are associated with clinical presentation and functional outcome. *Schizophr Res*, 128(1-3), 117-123. Epub 2011 Feb 2018.
- Strauss, G. P., Hong, L. E., Gold, J. M., Buchanan, R. W., McMahon, R. P., Keller, W. R., . . . Kirkpatrick, B. (2012). Factor structure of the Brief Negative Symptom Scale. *Schizophr Res*, 142(1-3), 96-98. doi: 10.1016/j.schres.2012.09.007
- Strauss, G. P., Keller, W. R., Buchanan, R. W., Gold, J. M., Fischer, B. A., McMahon, R. P., . . . Kirkpatrick, B. (2012). Next-generation negative symptom assessment for clinical trials: validation of the Brief Negative Symptom Scale. *Schizophr Res*, 142(1-3), 88-92. doi: 10.1016/j.schres.2012.10.012
- Strauss, G. P., Morra, L. F., Sullivan, S. K., & Gold, J. M. (2014). The Role of Low Cognitive Effort and Negative Symptoms in Neuropsychological Impairment in Schizophrenia. *Neuropsychology*. doi: 10.1037/neu0000113
- Strauss, G. P., Robinson, B. M., Waltz, J. A., Frank, M. J., Kasanova, Z., Herbener, E. S., & Gold, J. M. (2011). Patients with schizophrenia demonstrate inconsistent preference judgments for affective and nonaffective stimuli. *Schizophr Bull*, 37(6), 1295-1304. doi: 10.1093/schbul/sbq1047. Epub 2010 May 2019.
- Strauss, G. P., Waltz, J. A., & Gold, J. M. (2013). A Review of Reward Processing and Motivational Impairment in Schizophrenia. *Schizophr Bull*. doi: 10.1093/schbul/sbt197
- Strauss, G. P., Wilbur, R. C., Warren, K. R., August, S. M., & Gold, J. M. (2011). Anticipatory vs. consummatory pleasure: what is the nature of hedonic deficits in schizophrenia? *Psychiatry Research*, 187(1-2), 36-41. Epub 2011 Feb 2015.
- Strauss, J. S., Carpenter, W. T., Jr., & Bartko, J. J. (1974). The diagnosis and understanding of schizophrenia. Part III. Speculations on the processes that underlie schizophrenic symptoms and signs. *Schizophr Bull*(11), 61-69.
- Suslow, T., Junghanns, K., Weitzsch, C., & Arolt, V. (1998). Relations between neuropsychological vulnerability markers and negative symptoms in schizophrenia. *Psychopathology*, 31(4), 178-187.
- Swartz, M. S., Perkins, D. O., Stroup, T. S., Davis, S. M., Capuano, G., Rosenheck, R. A., . . . Lieberman, J. A. (2007). Effects of antipsychotic medications on psychosocial functioning in patients with chronic schizophrenia: findings from the NIMH CATIE study. *Am J Psychiatry*, 164(3), 428-436. doi: 10.1176/appi.ajp.164.3.428
- Szendi, I., Kiss, M., Racsmány, M., Boda, K., Cimmer, C., Voros, E., . . . Janka, Z. (2006). Correlations between clinical symptoms, working memory functions and structural brain abnormalities in men with schizophrenia. *Psychiatry Res*, 147(1), 47-55. Epub 2006 Mar 2020.
- Tabachnick, B., Fidell, L. (2013). *Using Multivariate Statistics* (6th ed.): Pearson.
- Tarrier, N. (2010). Broad Minded Affective Coping (BMAC): A "Positive" CBT Approach to Facilitating Positive Emotions. *International Journal of Cognitive Therapy*, 3(1), 64-76. doi: 10.1521/ijct.2010.3.1.64
- Tellegen, A., Watson, D., & Clark, L. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of personality and social psychology*, 54(6), 1063-1070.
- The Schizophrenia Commission. (2012). The abandoned illness: a report from the Schizophrenia Commission. London: Rethink Mental Illness.
- Thewissen, V., Bentall, R. P., Oorschot, M., J. A. C., van Lierop, T., van Os, J., & Myin-Germeys, I. (2011). Emotions, self-esteem, and paranoid episodes: an experience sampling study. *Br J Clin Psychol*, 50(2), 178-195. doi: 10.1348/014466510X508677

- Treadway, M. T., Buckholtz, J. W., Schwartzman, A. N., Lambert, W. E., & Zald, D. H. (2009). Worth the 'Effort'? The effort expenditure for rewards task as an objective measure of motivation and anhedonia. *PLoS One*, 4(8), e6598. doi: 10.1371/journal.pone.0006598
- Treadway, M. T., Peterman, J. S., Zald, D. H., & Park, S. (2015). Impaired effort allocation in patients with schizophrenia. *Schizophr Res*, 161(2-3), 382-385. doi: 10.1016/j.schres.2014.11.024
- Trémeau, F., Antonius, D., Cacioppo, J. T., Ziwich, R., Butler, P., Malaspina, D., & Javitt, D. C. (2010). Anticipated, on-line and remembered positive experience in schizophrenia. *Schizophrenia Research*, 122(1-3), 199-205. Epub 2009 Nov 2010.
- Trémeau, F., Antonius, D., Cacioppo, J. T., Ziwich, R., Jalbrzikowski, M., Saccente, E., . . . Javitt, D. (2009). In support of Bleuler: objective evidence for increased affective ambivalence in schizophrenia based upon evocative testing. *Schizophr Res.*, 107(2-3), 223-231. Epub 2008 Oct 2022.
- Trémeau, F., Antonius, D., Nolan, K., Butler, P., & Javitt, D. C. (2014). Immediate affective motivation is not impaired in schizophrenia. *Schizophrenia Research*(0). doi: <http://dx.doi.org/10.1016/j.schres.2014.08.001>
- Trémeau, F., Goldman, J., Antonius, D., & Javitt, D. C. (2013). Inpatients with schizophrenia report impaired situational motivation but intact global and social motivation. *Psychiatry Res*, 210(1), 43-49. doi: 10.1016/j.psychres.2013.05.031
- Tso, I. F., Grove, T. B., & Taylor, S. F. (2014). Differential hedonic experience and behavioral activation in schizophrenia and bipolar disorder. *Psychiatry Research*. doi: 10.1016/j.psychres.2014.06.030
- Tully, L. M., Lincoln, S. H., & Hooker, C. I. (2012). Impaired executive control of emotional information in social anhedonia. *Psychiatry Res*, 197(1-2), 29-35. doi: 10.1016/j.psychres.2011.12.023
- Turkington, D., Kingdon, D., & Weiden, P. J. (2006). Cognitive behavior therapy for schizophrenia. *Am J Psychiatry*, 163(3), 365-373. doi: 10.1176/appi.ajp.163.3.365
- Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science*, 185(4157), 1124-1131. doi: 10.1126/science.185.4157.1124
- Udachina, A., Varese, F., Myin-Germeys, I., & Bentall, R. P. (2014). The role of experiential avoidance in paranoid delusions: an experience sampling study. *Br J Clin Psychol*, 53(4), 422-432. doi: 10.1111/bjc.12054
- Udachina, A., Varese, F., Oorschot, M., Myin-Germeys, I., & Bentall, R. P. (2012). Dynamics of self-esteem in "poor-me" and "bad-me" paranoia. *J Nerv Ment Dis*, 200(9), 777-783. doi: 10.1097/NMD.0b013e318266ba57
- Ursu, S., Kring, A. M., Gard, M. G., Minzenberg, M. J., Yoon, J. H., Ragland, J. D., . . . Carter, C. S. (2011). Prefrontal cortical deficits and impaired cognition-emotion interactions in schizophrenia. *Am J Psychiatry*, 168(3), 276-285. Epub 2011 Jan 2014.
- Van den Oord, E. J., Rujescu, D., Robles, J. R., Giegling, I., Birrell, C., Bukszar, J., . . . Muglia, P. (2006). Factor structure and external validity of the PANSS revisited. *Schizophr Res*, 82(2-3), 213-223. doi: 10.1016/j.schres.2005.09.002
- van Os, J. (2009). Schizophrenia treatment: Content versus delivery. *Acta Psychiatrica Scandinavica*, 119(SUPPL. 438), 29-32. doi: 10.1111/j.1600-0447.2008.01311.x
- van Os, J., Hanssen, M., Bijl, R. V., & Vollebergh, W. (2001). Prevalence of psychotic disorder and community level of psychotic symptoms: An urban-rural comparison. *Archives of General Psychiatry*, 58(7), 663-668. doi: 10.1001/archpsyc.58.7.663
- van Os, J., Lataster, T., Delespaul, P., Wichers, M., & Myin-Germeys, I. (2014). Evidence that a psychopathology interactome has diagnostic value, predicting clinical needs: an experience sampling study. *PLoS One*, 9(1), e86652. doi: 10.1371/journal.pone.0086652
- van Os, J., Linscott, R. J., Myin-Germeys, I., Delespaul, P., & Krabbendam, L. (2009). A systematic review and meta-analysis of the psychosis continuum: evidence for a psychosis proneness-

- persistence-impairment model of psychotic disorder. *Psychol Med*, 39(2), 179-195. doi: 10.1017/s0033291708003814
- Velthorst, E., Koeter, M., van der Gaag, M., Nieman, D. H., Fett, A. K., Smit, F., . . . de Haan, L. (2014). Adapted cognitive-behavioural therapy required for targeting negative symptoms in schizophrenia: meta-analysis and meta-regression. *Psychol Med*, 1-13. doi: 10.1017/s0033291714001147
- Velthorst, E., Nieman, D. H., Becker, H. E., van de Fliert, R., Dingemans, P. M., Klaassen, R., . . . Linszen, D. H. (2009). Baseline differences in clinical symptomatology between ultra high risk subjects with and without a transition to psychosis. *Schizophr Res.*, 109(1-3), 60-65. Epub 2009 Mar 2009.
- Ventura, J., Subotnik, K. L., Gitlin, M. J., Gretchen-Doorly, D., Ered, A., Villa, K. F., . . . Nuechterlein, K. H. (2015). Negative symptoms and functioning during the first year after a recent onset of schizophrenia and 8years later. *Schizophr Res*, 161(2-3), 407-413. doi: 10.1016/j.schres.2014.10.043
- Vercammen, A., Morris, R., Green, M. J., Lenroot, R., Kulkarni, J., Carr, V. J., . . . Weickert, T. W. (2012). Reduced neural activity of the prefrontal cognitive control circuitry during response inhibition to negative words in people with schizophrenia. *Journal of Psychiatry and Neuroscience*, 37(6), 379-388. doi: 10.1503/jpn.110088
- Vijayananthan, A., & Nawawi, O. (2008). The importance of Good Clinical Practice guidelines and its role in clinical trials. *Biomedical Imaging and Intervention Journal*, 4(1), e5. doi: 10.2349/bij.4.1.e5
- Wallwork, R. S., Fortgang, R., Hashimoto, R., Weinberger, D. R., & Dickinson, D. (2012). Searching for a consensus five-factor model of the Positive and Negative Syndrome Scale for schizophrenia. *Schizophrenia Research*, 137(1-3), 246-250. doi: 10.1016/j.schres.2012.01.031
- Walter, H., Heckers, S., Kassubek, J., Erk, S., Frasch, K., & Abler, B. (2010). Further evidence for aberrant prefrontal salience coding in schizophrenia. *Front Behav Neurosci.*, 3, 62.
- Walter, H., Kammerer, H., Frasch, K., Spitzer, M., & Abler, B. (2009). Altered reward functions in patients on atypical antipsychotic medication in line with the revised dopamine hypothesis of schizophrenia. *Psychopharmacology (Berl)*. 206(1), 121-132. Epub 2009 Jun 2012.
- Waltz, J. A., Brown, J. K., Gold, J. M., Ross, T. J., Salmeron, B. J., & Stein, E. A. (2015). Probing the Dynamic Updating of Value in Schizophrenia Using a Sensory-Specific Satiety Paradigm. *Schizophrenia Bulletin*. doi: 10.1093/schbul/sbv034
- Waltz, J. A., & Gold, J. M. (2007). Probabilistic reversal learning impairments in schizophrenia: further evidence of orbitofrontal dysfunction. *Schizophr Res.*, 93(1-3), 296-303. Epub 2007 May 2007.
- Waltz, J. A., Schweitzer, J. B., Gold, J. M., Kurup, P. K., Ross, T. J., Salmeron, B. J., . . . Stein, E. A. (2009). Patients with schizophrenia have a reduced neural response to both unpredictable and predictable primary reinforcers. *Neuropsychopharmacology.*, 34(6), 1567-1577. Epub 2008 Dec 1563.
- Waltz, J. A., Schweitzer, J. B., Ross, T. J., Kurup, P. K., Salmeron, B. J., Rose, E. J., . . . Stein, E. A. (2010). Abnormal responses to monetary outcomes in cortex, but not in the basal ganglia, in schizophrenia. *Neuropsychopharmacology.*, 35(12), 2427-2439. Epub 2010 Aug 2418.
- Wang, C. S., Yang, Y. K., Chen, M., Chiu, N. T., Yeh, T. L., & Lee, I. H. (2003). Negative symptoms and regional cerebral blood flow in patients with schizophrenia: a single photon emission computed tomography study. *Kaohsiung J Med Sci.*, 19(9), 464-469.
- Wang, Y., Lui, S. S. Y., Zou, L.-q., Zhang, Q., Zhao, Q., Yan, C., . . . Chan, R. C. K. (2014). Individuals with psychometric schizotypy show similar social but not physical anhedonia to patients with schizophrenia. *Psychiatry Research*, 216(2), 161-167. doi: <http://dx.doi.org/10.1016/j.psychres.2014.02.017>
- Wilson, T. D., & Gilbert, D. T. (2005). Affective Forecasting: Knowing What to Want. *Current Directions in Psychological Science*, 14(3), 131-134. doi: 10.1111/j.0963-7214.2005.00355.x

- Woodruff, P. W., Phillips, M. L., Rushe, T., Wright, I. C., Murray, R. M., & David, A. S. (1997). Corpus callosum size and inter-hemispheric function in schizophrenia. *Schizophr Res.*, 23(3), 189-196.
- Woods, S. W. (2003). Chlorpromazine equivalent doses for the newer atypical antipsychotics. *J Clin Psychiatry*, 64(6), 663-667.
- World Health Organisation. (1992). *ICD-10 Classifications of Mental and Behavioural Disorder: Clinical Descriptions and Diagnostic Guidelines*. Geneva: World Health Organisation
- Wykes, T. (2014). Cognitive-behaviour therapy and schizophrenia. *Evid Based Ment Health*, 17(3), 67-68. doi: 10.1136/eb-2014-101887
- Wykes, T., Huddy, V., Cellard, C., McGurk, S. R., & Czobor, P. (2011). A meta-analysis of cognitive remediation for schizophrenia: methodology and effect sizes. *American Journal of Psychiatry*, 168(5), 472-485. doi: 10.1176/appi.ajp.2010.10060855
- Wykes, T., Newton, E., Landau, S., Rice, C., Thompson, N., & Frangou, S. (2007). Cognitive remediation therapy (CRT) for young early onset patients with schizophrenia: an exploratory randomized controlled trial. *Schizophr Res*, 94(1-3), 221-230. doi: 10.1016/j.schres.2007.03.030
- Wykes, T., Reeder, C., Corner, J., Williams, C., & Everitt, B. (1999). The effects of neurocognitive remediation on executive processing in patients with schizophrenia. *Schizophr Bull*, 25(2), 291-307.
- Wykes, T., Steel, C., Everitt, B., & Tarrier, N. (2008). Cognitive Behavior Therapy for Schizophrenia: Effect Sizes, Clinical Models, and Methodological Rigor. *Schizophrenia Bulletin*, 34(3), 523-537. doi: 10.1093/schbul/sbm114
- Wynn, J. K., Horan, W. P., Kring, A. M., Simons, R. F., & Green, M. F. (2010). Impaired anticipatory event-related potentials in schizophrenia. *Int J Psychophysiol.*, 77(2), 141-149. Epub 2010 Jun 2014.
- Yan, C., Cao, Y., Zhang, Y., Song, L. L., Cheung, E. F., & Chan, R. C. (2012). Trait and state positive emotional experience in schizophrenia: a meta-analysis. *PLoS One*, 7(7), e40672. Epub 42012 Jul 40618.

Appendices

Appendix 1: PRISMA criteria completed for the systematic review (Chapter 2)

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	48
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	N/A
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	48/49
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	49
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	N/A

Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	50
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	50
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	50
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	50
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	50
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	50
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	51

Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	51
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	52
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Appendix 2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Appendix 2
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence	N/A

		intervals, ideally with a forest plot.	
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	73
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	73-75
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	73/74
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	75
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	Acknowledgements

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097
For more information, visit: www.prisma-statement.org.

Appendix 2: Full Table of Studies Included in Systematic Review and Categorisation by TEP Model Construct

	Sample Size	Negative Symptom Measure	Method	Findings	TEP Model Construct
Barch et al. (2008)	66 SCZ or schizoaffective disorder/44 controls.	SANS + Chapman Scales	Motivational Trait Questionnaire WAIS III Matrix Reasoning, WAIS III Vocabulary, 2-back version of the n-back task, AX version of the Continuous Performance Task.	No association found with motivational traits and anhedonia. Results for cognition and anhedonia not reported.	Approach Motivation and Behaviours
Barch et al. (2014)	59 people with schizophrenia/39 matched controls.	SANS, Chapman Scales, SHAPS, TEPS.	Effort-Expenditure for Rewards Task	Individuals with schizophrenia show lower effort expenditure with increasing reward or probability than controls. Fewer difficult choices associated with more severe negative symptoms and worse functioning.	Approach Motivation and Behaviours
Becerril and Barch (2011)	38 SCZ/32 controls	SANS Chapman Scales	2-back working memory task with emotional faces. fMRI	Social anhedonia associated with diminished responses to emotional stimuli and increased dorsolateral prefrontal	Executive Functions and Activation/Maintenance of Representation

cortex activity.					
Berenbaum et al. (2008)	47 SCZ	SANS	Verbal and design fluency tasks. Working memory tasks- reading span and AX-CPT. Digits forward subtest of WAIS-R as measure attention. Lateralised motor performance task.	Anhedonia did not correlate with the measures of fluency, working memory or attention. Anhedonia did correlate with lateralised task performance.	Executive Functions and Activation/Maintenance of Representation
Berlin, Givry-Steiner, Lecrubier, and Puech (1998)	20 SCZ/20 major depression/20 healthy controls.	Chapman Scales	Hedonic responses to sucrose.	Hedonic response to sucrose was inversely correlated with Physical Anhedonia.	Consummatory Pleasure
Bodapati and Herbenet (2014)	38 SCZ/53 matched healthy controls	PANSS	In the moment emotional responses to social and non-social stimuli- IAPS images.	Control more aroused by social vs. non-social images- not in SCZ group. Negative symptom severity predicted lower arousal responses to unpleasant stimuli.	Consummatory Pleasure
Brebion et al. (1999)	33 SCZ/40 healthy controls.	SANS	Free recall and recognition memory tasks.	Fewer errors associated with anhedonia in SCZ group.	Memory
Brebion et al. (2005)	41 SCZ/43 healthy controls.	SANS	Verbal recognition task.	Anhedonia correlated with a reduced response bias.	Memory

Brebion, David, Jones, et al. (2007)	41 SCZ/43 healthy controls.	SANS	Temporal context memory task.	Anhedonia associated with significantly fewer errors.	Memory
Brebion, David, Ohlsen, et al. (2007)	41 SCZ	SANS	Visual memory task-recognition and spatial memory.	Anhedonia was associated with response bias, in the opposite direction from hallucinations (increased accuracy).	Memory
Brebion et al. (2010)	41 SCZ/43 healthy controls.	SANS	Production of atypical category exemplars.	Anhedonia significantly inversely correlated with typicality score.	Memory
Brebion et al. (2012)	41 SCZ/43 healthy controls.	SANS	Source memory, recall and recognition tasks for words and pictures.	Verbal, visual and source memory errors inversely correlated with anhedonia scores.	Memory
Buck et al. (2014)	163 SCZ; 52 high depression/high anhedonia, 52 low depression/low anhedonia, 59 low depression/high anhedonia.	PANSS	Wisconsin Card Sorting Task, Metacognition questionnaire, Bell-Lysaker Emotional Recognition Task.	No difference between depression/anhedonia groups in number of categories correct on the WCST. High anhedonia/low depression group had worse metacognition and social cognition scores.	Executive Functions and Activation/Maintenance of Representation
Burbridge and Barch (2007)	49 SCZ/47 healthy controls.	Chapman Scales	Ratings of emotional stimuli and tests of working and episodic memory.	Limited evidence for a link between working memory and physical anhedonia. No	Executive Functions and Activation/Maintenance of Representation

				other associations. No difference in emotional ratings between SCZ and controls.	
Chan et al. (2010)	21 SCZ with high negative symptoms/ 34 SCZ with low negative symptoms	TEPS PANSS	TEPS ratings completed in both groups to assess anticipatory and consummatory pleasure.	People with high negative symptoms had low anticipatory pleasure but intact consummatory pleasure compared to those with low negative symptoms.	Anticipatory Pleasure
Choi et al. (2013)	15 SCZ/17 controls.	Chapman Scales, PANSS.	Participants rated the pleasantness of both a preview and viewing stage of a film clip. fMRI.	There was no difference between groups in anticipatory or consummatory pleasure ratings. There was reduced activation in the anterior cingulate cortex during the preview phase in the SZ group.	Anticipatory Pleasure
Cicero, Martin, Becker, and Kerns (2014)	54 SCZ/32 controls	Chapman Scales	Probabilistic Selection Task	People with schizophrenia showed a deficit learning from both positive and negative feedback. These persisted even when given extra trials to learn the reward contingencies. Neither positive	Executive Functions and Activation/Maintenance of Representation

				or negative reinforcement learning was associated with anhedonia.	
Cohen and Minor (2010)	26 studies.	N/A	Meta-analysis.	Patients with SCZ do not differ from controls when rating their subjective hedonic experience to stimuli.	Consummatory Pleasure
Cohen et al. (2011)	32 SCZ/25 affective disorder patients/49 high positive schizotypy/32 high negative schizotypy/35 healthy controls.	SANS	Self-reported affective reactions to neutral, negative and positive stimuli.	In both schizotypy and schizophrenia groups negative symptoms were associated with less pleasant reports.	Consummatory Pleasure
Crespo-Facorro et al. (2001)	18 SCZ/16 healthy controls	SANS	Studying brain responses to olfactory stimuli using positron emission tomography	Patients failed to activate limbic/paralimbic regions and recruit a compensatory set of frontal cortical regions instead. Ratings of anhedonia did not correlate with blood flow or pleasantness scores.	Consummatory Pleasure
Demily et al. (2010)	21 SCZ/20 healthy controls.	Chapman scales.	Emotional Stroop task.	Slower RTs in SCZ group. No interactions or associations with anhedonia scores.	Executive Functions and Activation/Maintenance of Representation

Dichter et al. (2010)	16 SCZ/13 matched controls	SANS	Forced-choice visual oddball task. fMRI	Activation of the anterior cingulate during the task was inversely correlated with anhedonia.	Executive Functions and Activation/Maintenance of Representation
Doop and Park (2006)	17 SCZ/14 matched healthy controls.	SANS	University of Pennsylvania Smell identification Test (UPSIT)	Pleasantness ratings had a reduced range in SCZ and positively correlated with affective flattening but not anhedonia.	Consummatory Pleasure
Docx et al. (2015)	40 SCZ/30 matched controls	SANS	Effort Discounting Task	There was no difference between groups in the effort-discounting curves. The effort-discounting in the patient group did not correlate with symptom measures.	Approach Motivation and Behaviours
Dowd and Barch (2010)	40 SCZ/32 healthy controls	SANS Chapman Scales	Rating valence and arousal to images. fMRI	Higher anhedonia associated with reduced activation to positive vs. negative stimuli in the amygdala and right ventral striatum in patients.	Consummatory Pleasure
Dowd and Barch (2012)	25 SCZ/20 healthy controls	Chapman scales	Pavlovian reward prediction paradigm. fMRI	Group level neural responses to anticipation and receipt of reward similar. Individual	Executive Functions and Activation/Maintenance of Representation

				difference analyses revealed an association between physical anhedonia and activity in the ventral striatum and ventromedial prefrontal cortex.	
Folley and Park (2010)	18 SCZ outpatients /18 healthy controls.	SANS	Participants indicated which of two photographs of food they preferred and gave hedonic ratings of the pictures.	The use of fewer positive ratings correlated with increased anhedonia. SCZ individuals gave more positive ratings than controls overall.	Consummatory Pleasure
Franke et al. (1994)	35 SCZ/26 healthy siblings/35 healthy controls.	Chapman Scales	Continuous Performance Test- Identical Pairs Version	No association found with anhedonia scores in SCZ group or siblings.	Executive Functions and Activation/Maintenance of Representation
Gard et al. (2007)	Study 1: 10 SCZ + 5 schizoaffective disorder/12 healthy controls. Study 2: 50 SCZ + 1 schizoaffective disorder/50 healthy controls.	TEPS Chapman Scales SANS	Experience Sampling Methodology Questionnaires	Patients reported similar pleasure levels to controls during goal-directed activities but did them less often. Reduced anticipatory pleasure in clinical group on TEPS which correlated with SANS and Chapman scales. Intact consummatory pleasure.	Anticipatory Pleasure

Gard et al. (2011)	28 SZ/19 healthy controls	PANSS	Emotion maintenance task with a 3 second delay between the two viewing phases. Images used.	People with schizophrenia had similar "in the moment" ratings of pleasure but reduced positive and negative affect over the delay period.	Executive Functions and Activation/Maintenance of Representation
Gard, Sanchez, Cooper, et al. (2014)	47 SCZ/41 healthy controls	PANSS	Experience sampling methodology-current activity and anticipation of upcoming goals. These were coded independently for pleasure and effort. MATRICS battery	People with schizophrenia set fewer effortful goals and did fewer effortful activities than controls. They also showed greater inaccuracy at estimating the accuracy of goals which was associated with lower neurocognition. Compared to controls people with schizophrenia anticipated higher pleasure from goals and did more pleasure-based activities.	Approach Motivation and Behaviours
Gold et al. (2008)	8 studies presented: Patients with SCZ and demographically matched controls.	SANS	Reward Processing Tasks e.g. Wisconsin Card-Sorting Task and responses to IAPS images.	Some modest correlations (.3-.4) between performance on these tasks and negative symptoms but most very low.	Executive Functions and Activation/Maintenance of Representation

Gradin et al. (2011)	15 SCZ/15 individuals with depression/ 17 healthy controls.	PANSS	Instrumental reward learning task. fMRI	Reduced prediction error signals observed in schizophrenia but these did not correlate with any negative symptoms.	Executive Functions and Activation/Maintenance of Representation
Hammer et al. (1995)	65 SCZ	SANS	Neuropsychological Tests	Anhedonia correlated with preservative errors on the WCST and performance on the word fluency and Trail Making A tasks.	Executive Functions and Activation/Maintenance of Representation
P. O. Harvey et al. (2009)	29 SCZ/27 matched healthy controls.	Chapman scales	Emotional face recognition memory involving happy, sad and neutral expressions.	No difference in pleasure ratings between controls and people with SCZ. No correlation between social anhedonia and memory performance.	Memory
P. O. Harvey et al. (2010)	30 SCZ/26 healthy controls	Chapman Scales	Emotional Picture Viewing Task. fMRI	Anhedonia inversely correlated with activity in the orbitofrontal cortex and putamen/ventral striatum in the patient group.	Consummatory Pleasure

Heerey and Gold (2007)	41 patients with schizophrenia or schizoaffective disorder/31 healthy controls.	SANS	Rate IAPS stimuli for valence and arousal. Participants could prolong or decrease their exposure to certain stimuli in one condition and in the other increase or decrease their likelihood of future exposure to a stimulus.	Patients with SCZ showed weaker correspondence between their ratings and their behaviour than controls.	Approach Motivation and Behaviours
Herbener et al. (2007)	33 SCZ/28 healthy controls.	Chapman Scales	Emotional ratings of images then 24hr delay recognition task.	Higher levels of emotional intensity in SCZ group. Reduced recognition for positive images compared to controls, no difference for negative images.	Memory
Herbener et al. (2008)	34 SCZ/35 matched healthy controls	Chapman Scales	Emotional responses to 131 IAPS images.	Emotional ratings and anhedonia scores correlated in both groups. Similar emotional responses in both groups.	Consummatory Pleasure
Horan et al. (2006)	30 SCZ outpatients /31 healthy controls.	SANS	Rated emotional responses to food and film clips then a recall task after 4hr delay.	No difference between SCZ group and control group.	Consummatory Pleasure

Horan et al. (2010)	38 SCZ/36 healthy controls.	Chapman Scales SANS	Measured event-related potentials during an affective picture viewing task.	Higher physical and social anhedonia was associated with lower valence ratings for pleasant images. Physical anhedonia correlated with smaller P2 responses in the unpleasant picture condition. No other measures of anhedonia correlated with any other ERP variables. Higher levels of anhedonia correlated with longer viewing times- more top-down influences on emotional processing?	Consummatory Pleasure
Juckel, Schlagenhauf, Koslowski, Filonov, et al. (2006)	10 SCZ typical neuroleptic s/10 SCZ atypical neuroleptic s/10 matched controls	PANSS	Incentive Monetary Delay Task	In patients treated with typical neuroleptics only reduced activation in the left ventral striatum was associated with negative symptoms.	Executive Functions and Activation/Maintenance of Representation

Juckel, Schlagenhauf, Koslowski, Wustenberg, et al. (2006)	10 SCZ (7 unmedicated, 3 unmedicated for 2 years)/10 healthy controls.	PANSS	fMRI during presentation of reward-predicting and loss-predicting stimuli in a Monetary Incentive Delay Task	Left ventral striatal BOLD response during reward anticipation was inversely correlated with PANSS negative symptom subscale score.	Executive Functions and Activation/Maintenance of Representation
Kamath, Moberg, Kohler, Gur, and Turetsky (2011)	54 SCZ/22 unaffected 1 st degree relatives/45 matched healthy controls	SANS	Suprathreshold Amyl Acetate Odor Intensity and Odor Pleasantness Rating Test	Individuals with schizophrenia under-estimate pleasure at low concentrations and over-estimate it compared to controls at higher concentrations. This abnormal pattern correlated with anhedonia/asociality subscale.	Consummatory Pleasure
Kemali et al. (1987)	21 male SCZ/19 healthy controls.	SANS	Spatial conditional associative learning task + Non-spatial conditional associative learning task.	No association found between anhedonia and spatial learning. Number of errors and time taken in the non-spatial learning task inversely correlated with anhedonia scores.	Executive Functions and Activation/Maintenance of Representation
Lacerda et al. (2007)	43 first-episode, antipsychotic-naïve SCZ/53 matched controls.	SANS	Structural MRI	Anhedonia scores correlate with the volume of the left orbitofrontal cortex.	Executive Functions and Activation/Maintenance of Representation

Larquet et al. (2010)	21 SCZ/10 orbitofrontal cortex patients/20 healthy controls.	Chapman Scales	Regret Gambling Task	No association between anhedonia and performance on neuropsychological measures.	Executive Functions and Activation/Maintenance of Representation
Laurent et al. (2000)	23 SCZ Outpatients ,/47 first-degree relatives/34 healthy controls.	Chapman Scales	SPAN, DS-CPT, WCST, Digit Symbol, Trail Making A and B, Stroop task	No associations between performance and anhedonia in the SCZ group.	Executive Functions and Activation/Maintenance of Representation
E. Lee et al. (2006)	21 SCZ/20 controls	PANSS	Valence and Arousal ratings to 60 IAPS images.	Similar emotional experience to controls. No association reported with anhedonia.	Consummatory Pleasure
J. S. Lee et al. (2012)	14 SCZ/16 healthy controls	Chapman Scales TEPS	Word-image association encoding task. fMRI	Activity in hippocampus and nucleus accumbens when performing association task correlates with physical anhedonia scores.	Executive Functions and Activation/Maintenance of Representation
Llerena et al. (2012)	26 studies	N/A	Meta-Analysis of arousal ratings during stimuli presentation.	Controls and people with schizophrenia experience similar arousal levels to unpleasant and pleasant stimuli. People with schizophrenia experience more arousal to neutral stimuli.	Consummatory Pleasure

Matsuza wa et al. (2015)	61 SCZ/50 matched controls	SANS	Iowa Gambling Task	People with schizophrenia showed impaired emotional learning- this was dependent on the certainty with which they adopted a strategy for positive gain. The deficit in emotional learning was associated with SANS anhedonia- asociality subscale scores.	Executive Functions and Activation/Maint enance of Representation
Mote et al. (2014)	88 people with recent- onset schizophren ia diagnosis/6 6 controls.	TEPS	TEPS administered to examine levels of anticipatory and consummator y pleasure in recent-onset group.	People with schizophrenia reported reduced anticipatory but not consummatory pleasure compared to controls.	Anticipatory Pleasure
Mucci et al. (2015)	28 SCZ/22 healthy controls	PANSS TEPS Chapman Physical Anhedoni a Scale	Monetary Incentive Delay Task. fMRI	People with schizophrenia with high avolition scores showed reduced dorsal caudate activation compared to patients with low avolition scores and controls. This finding was repeated for patients with deficit schizophrenia	Executive Functions and Activation/Maint enance of Representation

				compared to non-deficit and controls. Dorsal caudate activity was associated with avolition but not anhedonia in the patient group.	
Oorschoot et al. (2013)	149 SCZ or schizoaffective disorder/143 controls.	PANSS	Experience Sampling Methodology	Patients with high negative symptoms have similar emotional experience to controls, low negative symptom patients more unstable. No association reported with anhedonia.	Consummatory Pleasure
K. M. Park et al. (2009)	29 SCZ/21 healthy controls	Chapman Scales	18F-fluorodeoxyglucose positron emission tomography	Physical anhedonia correlated in resting state activities of the supplementary motor area, ventromedial and dorsolateral prefrontal cortex, insular gyrus and the precuneus in patients.	Executive Functions and Activation/Maintenance of Representation
I. H. Park et al. (2009)	24 SCZ/22 healthy controls	Chapman Scales	Fluoro-d-glucose positron emission tomography	Patients with prefrontal hypofunction showed more severe anhedonia than those without.	Executive Functions and Activation/Maintenance of Representation

I. H. Park et al. (2015)	20 SCZ/20 matched controls	Chapman Scales PANSS	Deterministic reinforcement learning task with variable intervals of contingency reversals fMRI	No difference in positive or negative reinforcement. Patients showed altered response valuation and initiation-related striatal activity and reduced vACC activation during reward approach initiation. rACC activation correlated with social anhedonia and amotivation.	Executive Functions and Activation/Maintenance of Representation
Quirk, Strauss, and Sloan (1998)	30 SCZ/10 controls	PANSS	Rating valence and arousal to 54 IAPS images.	Average valence slightly lower in SCZ group. No association with anhedonia.	Consummatory Pleasure
Roux et al. (2010)	21 patients with SCZ/21 healthy controls.	Chapman Scales	Explicit recognition task and Vocal emotional Stroop task.	Vocal emotional stroop score increased with social anhedonia.	Executive Functions and Activation/Maintenance of Representation
Sanchez et al. (2014)	47 SCZ/41 healthy controls	PANSS	Experience sampling methodology-ratings of mood and enjoyment of current activity. MATRICS neurocognitive battery.	People with schizophrenia had higher negative mood but similar positive mood and enjoyment to controls. People with schizophrenia had a weaker relationship between negative mood and current enjoyment of activities	Consummatory Pleasure

				compared to controls. Neurocognitive scores mediated this relationship in people with schizophrenia.	
Schlagenhauf et al. (2008)	10 SCZ on typical neuroleptics then again once switched Olanzapine/ 10 matched controls.	PANSS	Monetary Incentive Delay Task. fMRI	In patients treated with typical neuroleptics decreased left ventral striatal activation was correlated with negative symptoms.	Executive Functions and Activation/Maintenance of Representation
Schlenker, Cohen, and Hopman (1995)	34 male SCZ/24 male healthy controls.	Chapman Scales	Startle-elicited brinks measured during presentation of affective slides.	No difference in patients and controls in subjective or autonomic response to slides. No associations with anhedonia.	Consummatory Pleasure
F. Schneider et al. (1995)	40 SCZ/40 Controls	SANS	Emotion discrimination tasks and mood induction procedures.	Negative correlation present between mood induction scores and anhedonia subscale. No correlation between anhedonia and emotion discrimination.	Consummatory Pleasure
Simon et al. (2010)	15 SCZ/15 healthy controls	Chapman Scales	Probabilistic Monetary Incentive Delay Task. fMRI	No significant differences at group level in anticipation or receipt of reward. No associations with anhedonia scales.	Executive Functions and Activation/Maintenance of Representation

Stevens et al. (2002)	25 SCZ treated with olanzapine, 25 SCZ treated with classic neuroleptics, 25 matched controls.	SANS and SHAPS.	Serial Reaction Time task, Classic Eye-Blink Conditioning and Explicit Visuospatial Memory Task	No associations with anhedonia.	Memory
G. P. Strauss and Herbenic (2011)	49 outpatients with SCZ/50 healthy controls.	Chapman Scales	Rating IAPS images on valence and arousal scales.	60% rated similarly to controls, 40% showed an atypical profile.	Consummatory Pleasure
G. P. Strauss, Frank, et al. (2011)	51 outpatients with SCZ/39 healthy controls.	SANS	Temporal decision-making task-requiring trial-by-trial adjustment to maximise reward. Go NoGo Task.	Individuals with high negative symptoms showed more impairment on Go NoGo than those with low negative symptoms. Uncertainty-based exploration was reduced compared to controls and correlated with anhedonia.	Executive Functions and Activation/Maintenance of Representation
G. P. Strauss, Robinson, et al. (2011)	38 SCZ/27 healthy controls.	SANS	Subjects presented with pairs of positive stimuli and asked to indicate which they preferred.	Less differentiation between the valence levels but same pattern of results.	Consummatory Pleasure
G. P. Strauss, Morra, Sullivan, and	97 SCZ/63 healthy controls.	SANS, Chapman Scales	Victoria Symptom Validity Test to measure effort. WTAR	Global neurocognitive impairment predicted by low effort and	Executive Functions and Activation/Maintenance of Representation

Gold (2014)			and MATRICS cognitive tests.	negative symptoms.	
Suslow et al. (1998)	31 SCZ (predominantly negative symptoms)	SANS	Visual backward masking task, Span of Apprehension task, WCST and degraded stimulus Continuous Performance Test.	Card sorting preservative errors correlated with negatively with anhedonia. No other associations with anhedonia found.	Executive Functions and Activation/Maintenance of Representation
Szendi et al. (2006)	13 male SCZ/13 male controls	SANS	Structural MRI + Working Memory Tasks	Anhedonia negatively correlated with the relative volume of the left straight gyrus. No group differences in regions of interest. Anhedonia correlated with performance on the Tower of Hanoi and Corsi Blocks Backwards tasks.	Executive Functions and Activation/Maintenance of Representation
Trémeau et al. (2009)	64 SCZ/32 healthy controls.	Chapman Scales	Evocative emotional task with pictures, sounds and words of varying valence and intensity- participants rated pleasantness and arousal.	Ambivalence to positive stimuli correlated with anhedonia in SCZ.	Consummatory Pleasure

Trémeau et al. (2010)	70 SCZ/35 controls	SANS	Rating pleasantness and arousal in an evocative emotional task using pictures, sounds and words. Also rating pre-test anticipated pleasure and post-test remembered pleasure.	Emotional experience and anticipated pleasure was similar in both group. Remembered pleasure was higher in SCZ group. Anticipatory pleasure correlated with SANS total but not anhedonia.	Anticipatory Pleasure
Trémeau et al. (2014)	49 SCZ/25 healthy controls	Chapman Scales PANSS SANS	Participants were asked to rate their anticipatory pleasure before completing a task which involved viewing images.	People with schizophrenia rated their anticipatory pleasure as higher than controls.	Anticipatory Pleasure
Ursu et al. (2011)	23 SCZ/24 healthy controls.	SANS	Reporting emotional response to IAPS images after a short delay. fMRI.	Same brain activity in both groups when presented with images. During the delay after pleasant images reduced activation in the dorsolateral prefrontal cortex in patient group was seen which correlated with anhedonia.	Executive Functions and Activation/Maintenance of Representation
Walter et al. (2009)	16 SCZ/16 healthy controls.	Chapman Scales	fMRI during a delayed incentive paradigm with monetary	Dorsal anterior cingulate activation reduced in patient group in	Executive Functions and Activation/Maintenance of Representation

			rewards.	expectation phase but no correlations with negative symptom or anhedonia scores.	
Walter et al. (2010)	Study 1:16 SCZ/16 controls Study2: 12 SCZ/12 controls	Chapman Scales	Financial Reward Task	Aberrant salience coding seen in the ventromedial prefrontal cortex of patients with schizophrenia, the degree of this salience coding was inversely correlated with anhedonia scores.	Executive Functions and Activation/Maintenance of Representation
Waltz and Gold (2007)	34 SCZ/26 controls.	SANS	Probabilistic reversal learning task.	SCZ group worse at reversal learning but this did not correlate with anhedonia or negative symptoms.	Executive Functions and Activation/Maintenance of Representation
Waltz et al. (2009)	18 SCZ/18 healthy controls	Chapman Scales	Passive conditioning task. fMRI	Group differences generally driven by attenuated responses in patient group to positive temporal difference errors (unexpected juice deliveries). No associations reported with anhedonia scores.	Executive Functions and Activation/Maintenance of Representation

Waltz et al. (2010)	17 SCZ/17 matched controls.	SANS Chapman Scales	fMRI during monetary incentive delay task.	Significant correlation between activity in the right ventral striatum when viewing a cue predicting reward and anhedonia scores. Negative symptoms correlate with prefrontal cortex activity in response to gains and losses.	Executive Functions and Activation/Maintenance of Representation
Waltz et al. (2015)	42 SCZ/44 healthy controls	Chapman Scales SANS BNSS	Sensory-specific satiety paradigm.	Control participants showed an effect of satiety that was sensory-specific, whereas people with schizophrenia did not. Satiety effects correlated with positive and negative symptoms (Chapman physical and social scales and SANS anhedonia/avolition) in the schizophrenia group.	Executive Functions and Activation/Maintenance of Representation

Woodruff et al. (1997)	Full sample: 42 SCZ/43 healthy controls. Stroop task subsample: 27 SCZ/29 healthy controls	SANS	Structural MRI and modified Stroop Task	Negative correlation between anterior corpus callosum area and anhedonia scores. No association reported for Stroop task performance and anhedonia.	Executive Functions and Activation/Maintenance of Representation
Wynn et al. (2010)	34 SCZ/36 healthy controls	Chapman scales. SANS TEPS	Event Related Potentials (ERPs) and emotional responses whilst viewing images.	Similar patterns of emotional response in both groups. Lower ERPs in patient group. No association between ERP and anhedonia reported.	Consummatory Pleasure
Yan et al. (2012)	21 studies state arousal/40 studies state valence/47 studies trait hedonic capacity.	N/A	Meta-Analysis	No difference between controls and SCZ in state valence or arousal, lower trait hedonic capacity in SCZ group. Negative symptoms were a significant moderator for the effect size for trait hedonic capacity.	Consummatory Pleasure

Appendix 3: Image Ratings Questionnaire for COP Task Pilot Study

You will now be presented with a series of images. When each image is presented you will be asked to rate how pleasant the image is using a scale from 1 to 9 where 1 is very unpleasant and 9 very pleasant. The second scale will ask you how arousing/exciting the image is from very calm to very arousing. Could you also please categorise each item as neutral, physically pleasurable or socially pleasurable, each image must be placed in one category only.

Physical pleasure is derived from sources such as taste, sight, touch and smell.

Social pleasure is experienced in interpersonal scenarios such as talking to people or being with them.

Valence

Extremely Unpleasant									Extremely Pleasant
1	2	3	4	5	6	7	8	9	

Arousal

Extremely Calm									Extremely Arousing
1	2	3	4	5	6	7	8	9	

Positive- Physical	Positive-Social	Neutral
--------------------	-----------------	---------

Appendix 4: Verbal Instructions for COP Task

Phase 1: Consummatory Ratings

“You are going to be shown a series of images. When each picture is presented there are going to be two scales underneath which I would like you to use to rate it. The first scale asks you how pleasant the image is and that is from 1 very unpleasant to 9 very pleasant, 5 is the neutral point. The second scale will ask you how arousing the image is from 1 very calm to 9 very arousing. In psychology this means how emotional you find the picture. If the picture causes you to feel any emotions, good or bad, this should be rated on the scale. However, if you find the image does not make you feel anything it should be rated low on the scale. With each image it is important to rate it according to your first instinct and try not to think about it too much. Now we are going to do two practice images.”

“To rate the image select the number by clicking on it with the mouse. It will turn green once you have selected it. Once you have rated both scales click on the next button to move on to the next image.”

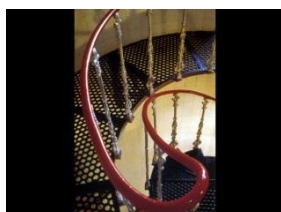
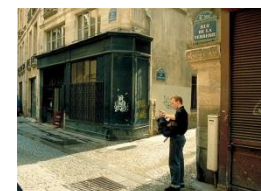
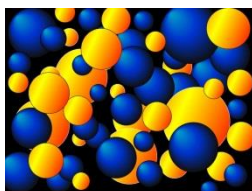
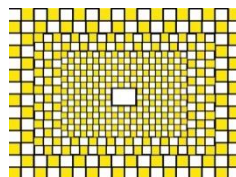
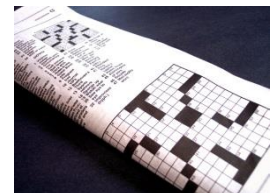
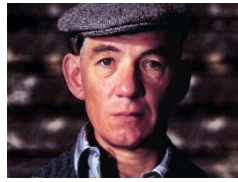
Phase 2: Learning Phase

“Now we are going to complete a short learning game. The computer has matched four of the images you saw previously, each to a specific shape as shown on the diagram. The aim of the game is for you to work out which shape is matched to each image. These pairings are specific so each image is not matched to more than one shape. The computer first of all shows you the shape on the screen, so for example a green diamond will appear. On the next screen will be two images, one of these is correct and matched to the shape, the other is not. Your task is to click on the image you believe to be the correct one. The computer will then tell you if you’re right or wrong. If you are right, then you have correctly identified the image matched to that shape and you just need to remember it for the next time you see that shape as it will not change. If you are wrong then just try your best next time you see that shape. The task will stop automatically once you have got each one right a few times.”

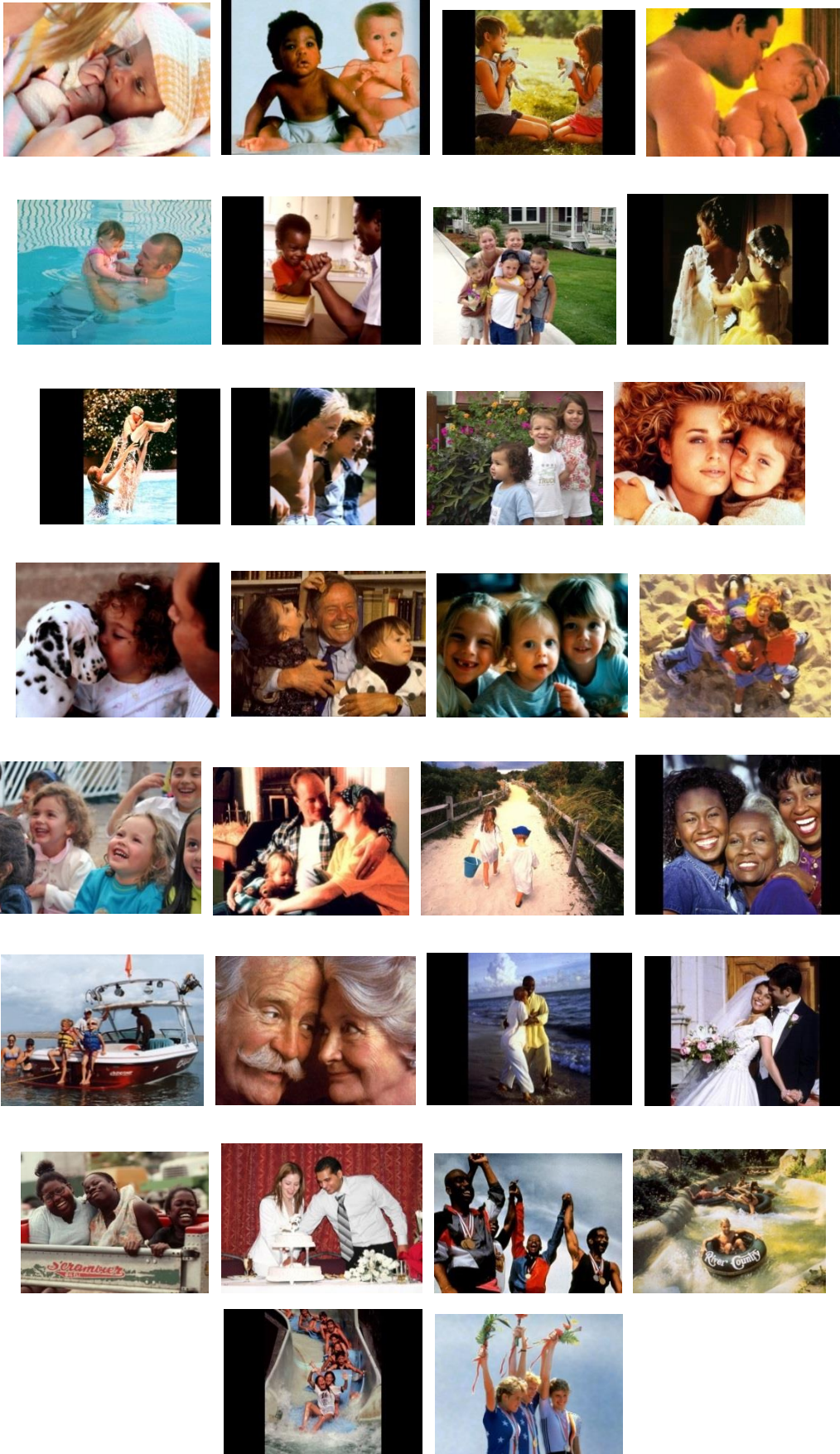
Phase 3 Learning Phase

“The computer is now going to ask you to remember which image is matched to each shape and rate how pleasant and how arousing that image would be if you were to see it again. This will be using the same two scales you used in the first half of the task. The computer will then ask you to click on the image you were thinking of for that shape. You will be asked to do this three times for each shape so when it asks you to repeat a rating it doesn’t mean you have selected the wrong image.”

Appendix 5: COP Task Neutral Images




Appendix 6: COP Task Social Images



Appendix 7: COP Task Physical Images



Appendix 8: Screenshot of COP Task Consummatory Rating



How pleasant is the image?

Very Unpleasant

1 2 3 4 5 6 7 8 9


Very Pleasant

How arousing is the image?

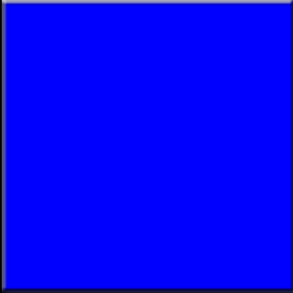
Very Calm

1 2 3 4 5 6 7 8 9

Very Arousing



Appendix 9: Screenshots of COP Task Anticipatory Phase Ratings



How pleasant will the image associated with this shape be?


Very Unpleasant Very Pleasant





1 2 3 4 5 6 7 8 9

How arousing will the image associated with this shape be?

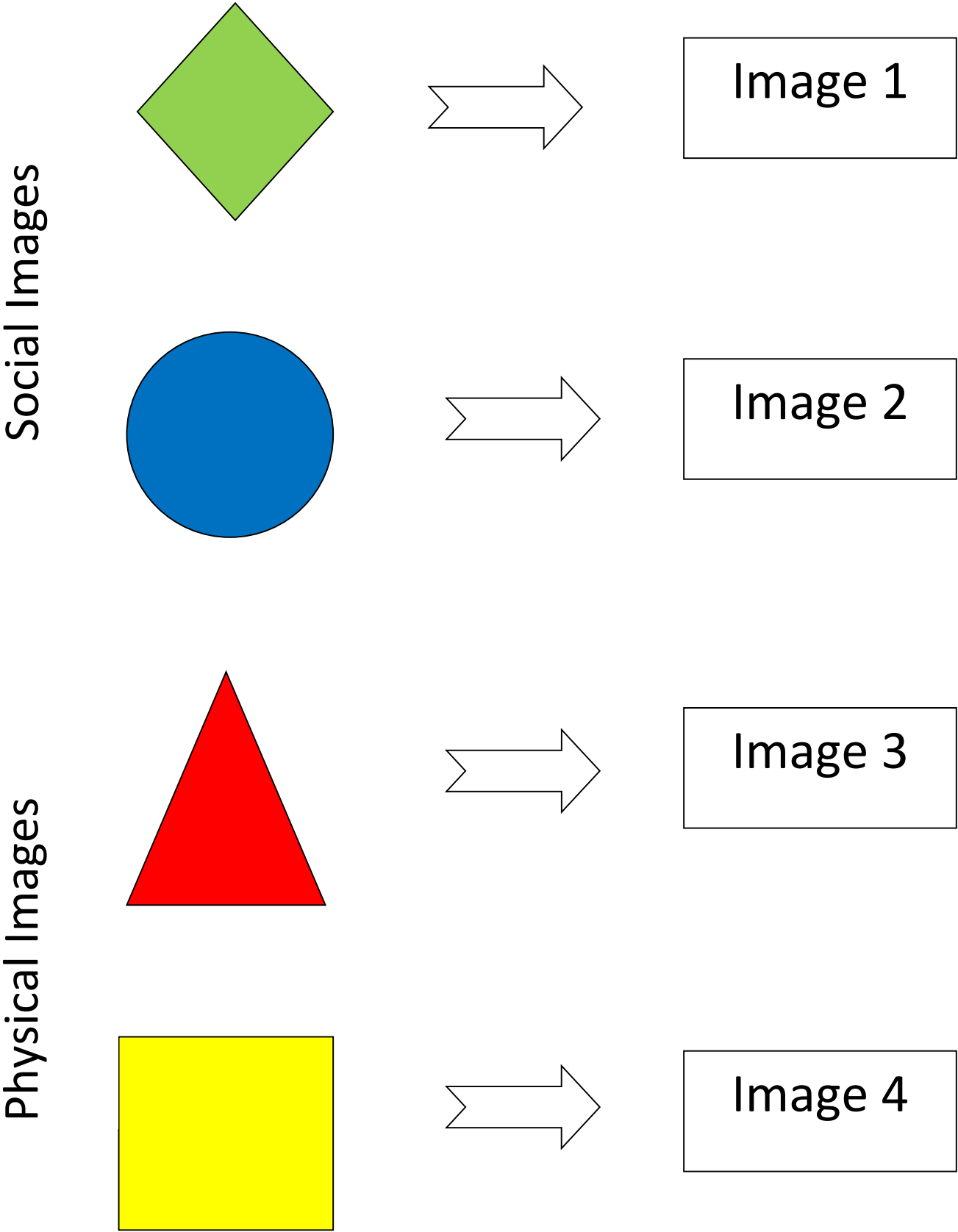
Very Calm Very Arousing

1 2 3 4 5 6 7 8 9

Please select the image associated with this shape: 

**Appendix 10: Learning Aid given to Participants during the Learning Phase
of the COP Task**



Appendix 11: Normality Analyses for Chapter 9: Q-Q Plots

Figure 29: Q-Q plot control group consummatory neutral valence

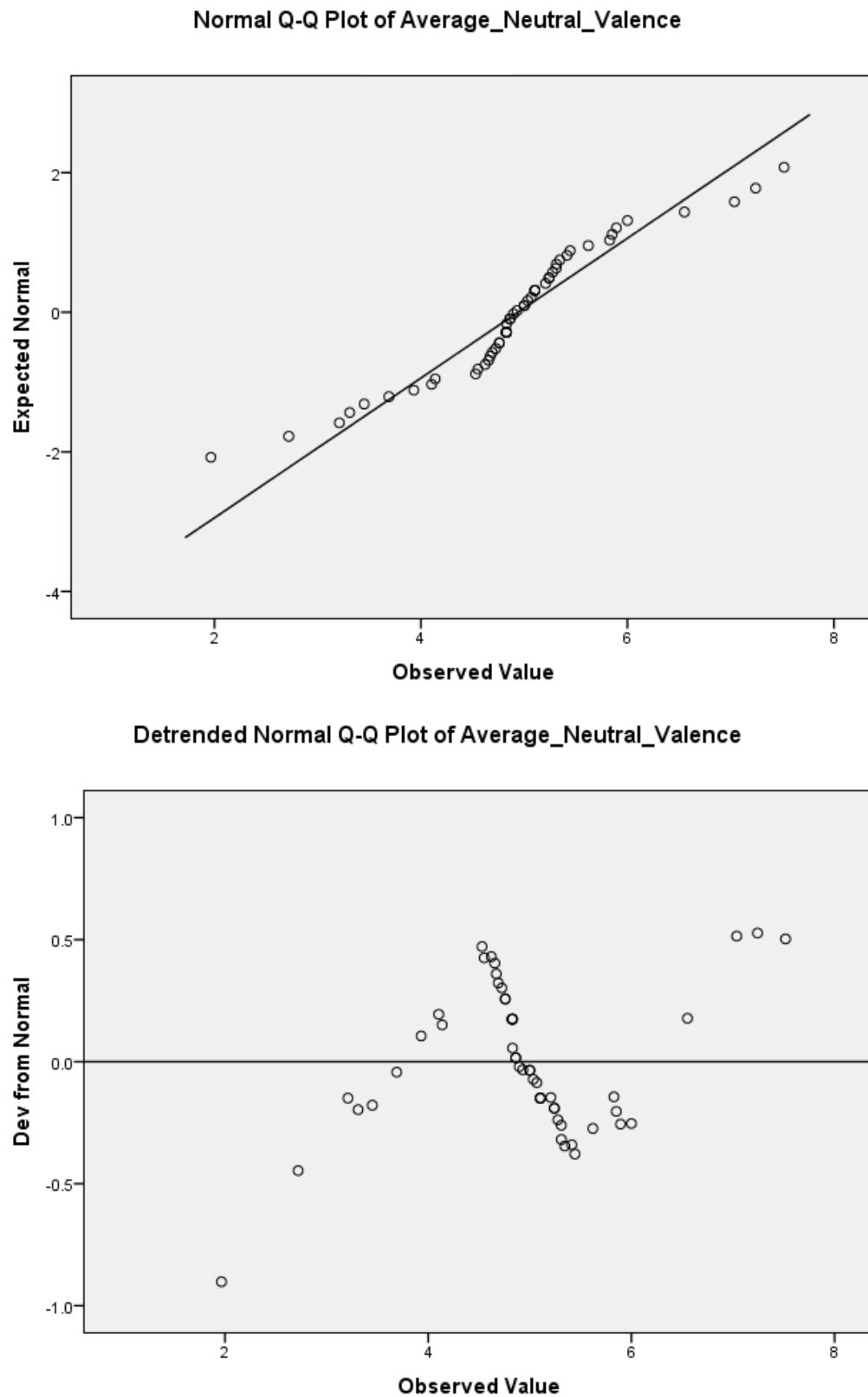


Figure 30: Q-Q plot schizophrenia group consummatory social valence

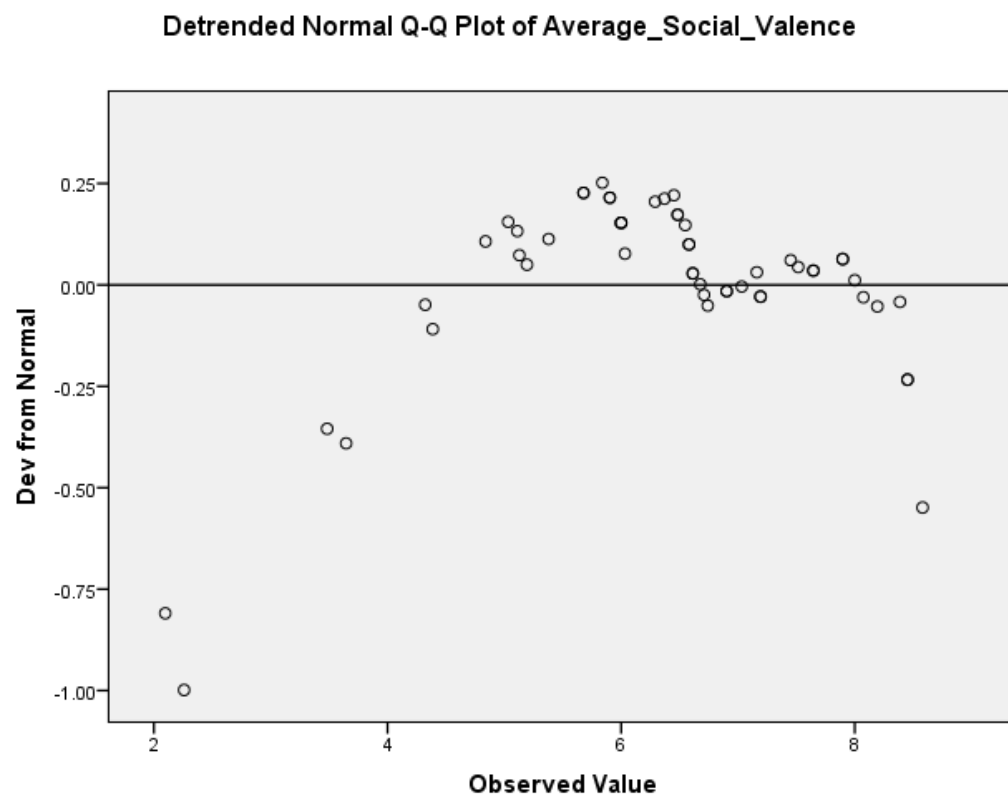
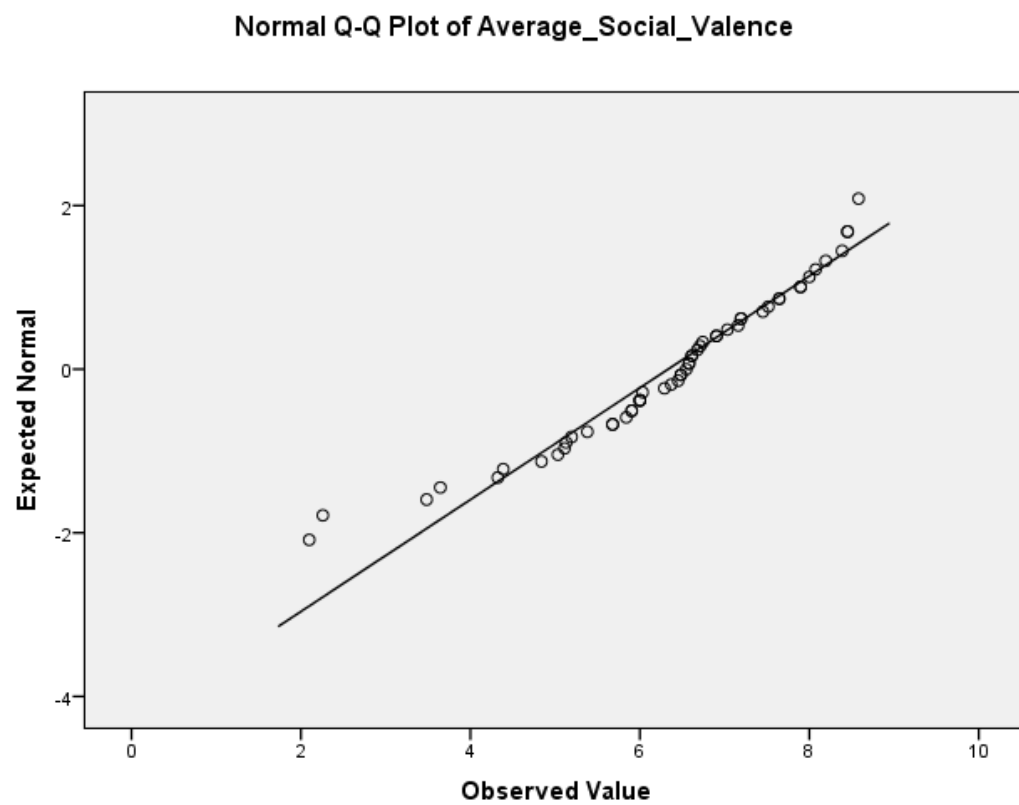


Figure 31: Q-Q Plot control group anticipatory social low valence

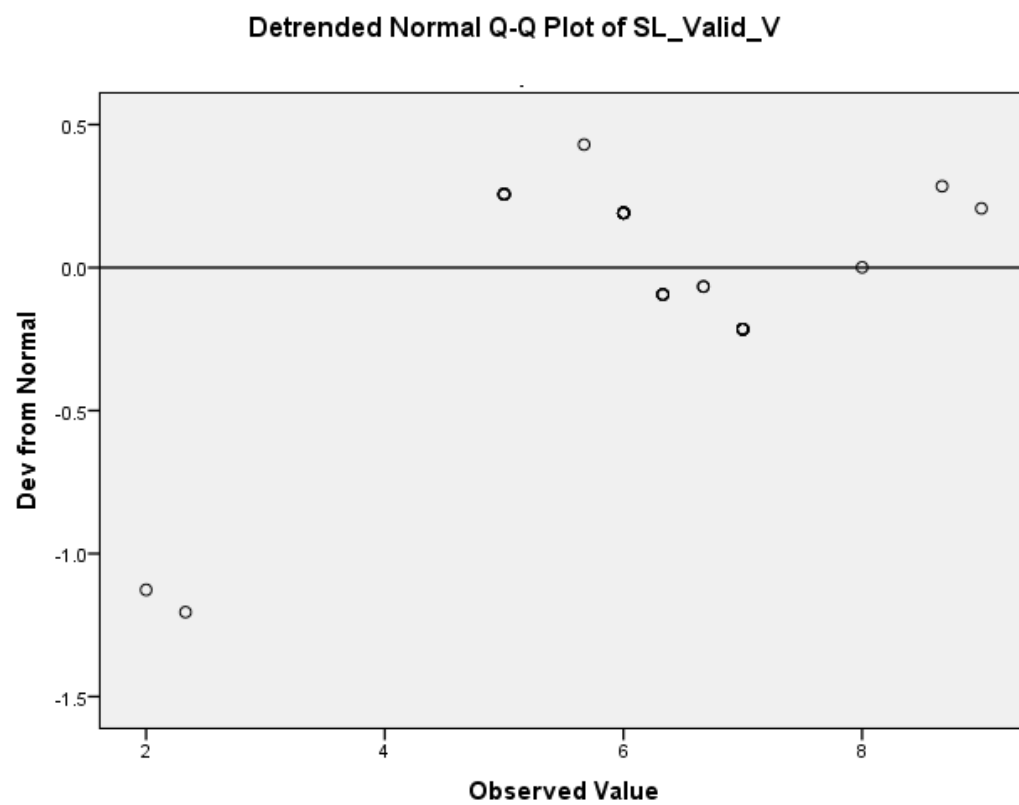
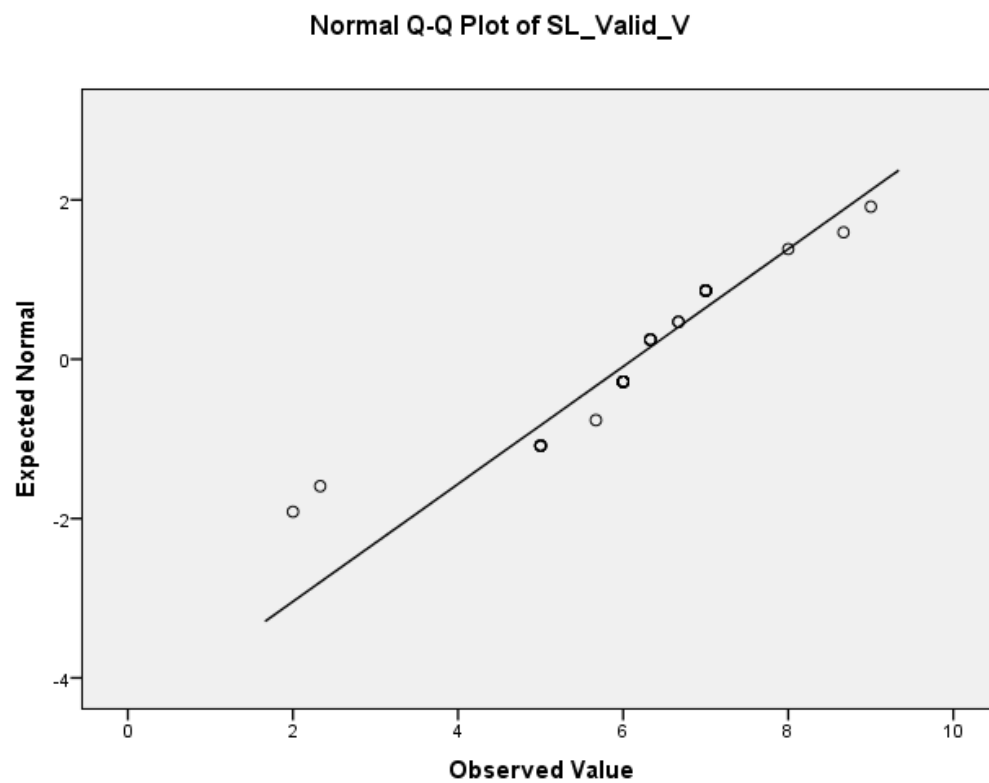
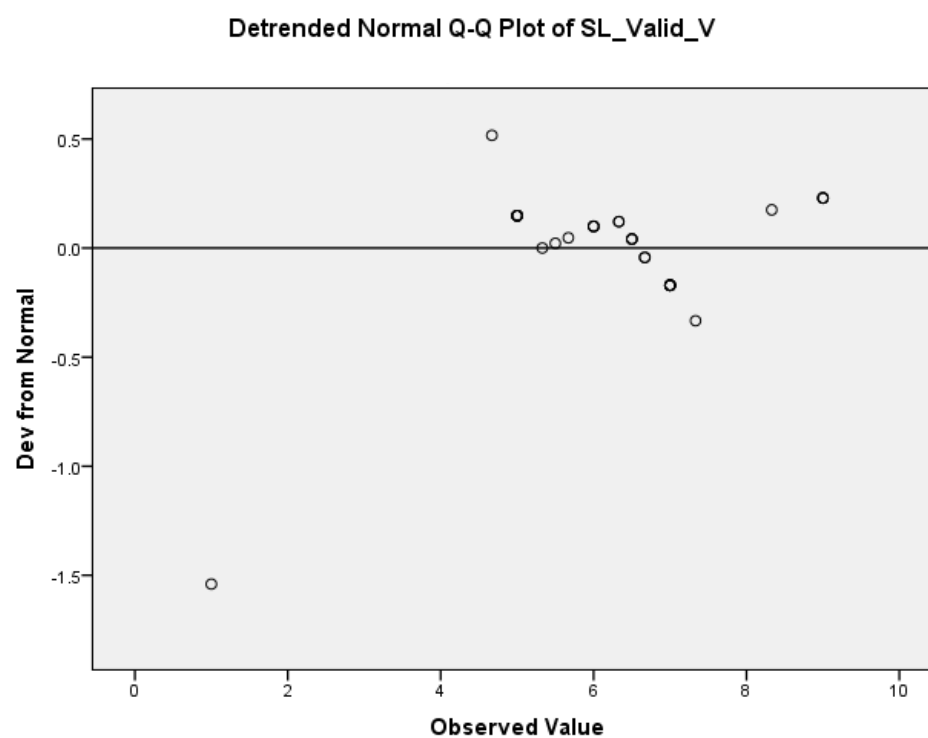
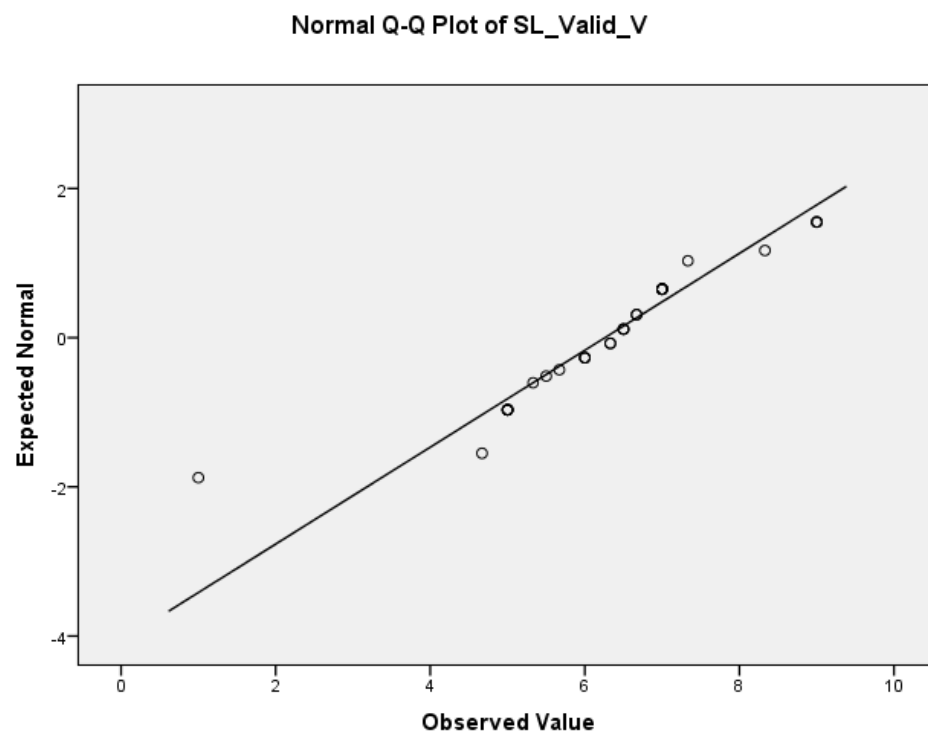


Figure 32: Q-Q plot schizophrenia group anticipatory social low valence



Appendix 12: Screenshots of ESM Questionnaire Items

Figure 33: Screenshot of ESM mood rating



The screenshot displays a mood rating interface on a black background. At the top, the text "Right now I feel" is centered in white. Below it, the word "Relaxed" is also centered in white. At the bottom, there is a horizontal scale with seven yellow square buttons numbered 1 to 7. The text "Not at all" is positioned above button 1, and "Very Much" is positioned above button 7. In the bottom left corner, there are four small, faint icons: a left arrow, a pencil, a list icon, and a right arrow.

Right now I feel

Relaxed

Not at all

Very Much

1 2 3 4 5 6 7

Figure 34: Screenshot of ESM current activity items

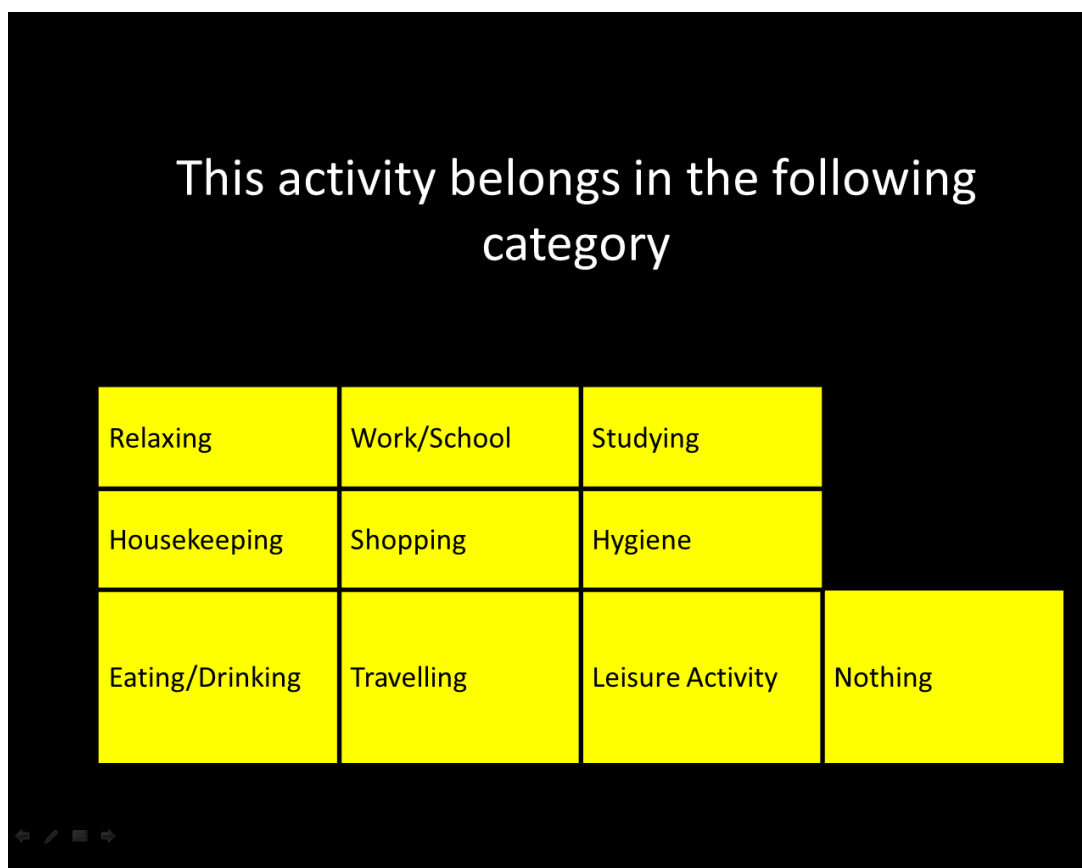


Figure 35: Screenshot of ESM consummatory pleasure rating

How much are you enjoying this activity?

Not at all Very Much

1 2 3 4 5 6 7

← →

Figure 36: Screenshot of ESM anticipatory activity categories

What do you think you will be doing in the next few hours?

Relaxing	Work/School	Studying	
Housekeeping	Shopping	Hygiene	
Eating/Drinking	Travelling	Leisure Activity	Nothing

← / →

Figure 37: Screenshot of ESM anticipatory pleasure rating

How much do you think you will enjoy this activity?

Not at all Very Much

1 2 3 4 5 6 7

← / →

Figure 38: Screenshot of ESM expectation rating

What do you think are the chances this activity will occur?

0%	1-9%	10-19%	20-29%
30-39%	40-49%	50-59%	60-69%
70-79%	80-89%	90-99%	100%